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Elk nutrition---the response of elk calves to various winter diets under controlled conditions

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ELK NUTRITION - THE RESPONSE OF ELK CALVES TO VARIOUS WINTER DIETS UNDER CONTROLLED CONDITIONS

by

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INTRODUCTION

In the field of range management, and particularly livestock management, proper management is based on a knowledge of the forage preference and needs of the animal and the degree of utilization of the various forage species which is consistent with sustained production. If nutritional requirements and the production of the forage plants are known, then the proper numbers of stock can be carried on the range. This results in optimum animal production and proper range management. This study is designed to yield data concerning the nutritional requirements of elk calves. A survey of the productiveness of the natural range of the elk has to be made for each particular area before game numbers can be regulated for optimum results. While forage quantity and quality may vary from location to location, the basic physiology of the elk will remain constant, even though their habits may vary. Therefore, data secured from a nutritional study of this nature may be applied to many areas where elk and elk range are to be managed.

Depletion of the food supply on the winter range has its first effect on the younger elk. They are less able to cope with the deep snow in search of food and therefore usually follow in the tracks of older animals, where most of the feed has been taken. One of the first effects of overbrowsing

may be the loss of the young, through malnutrition, and it is this young class of animals, the calves, upon which the perpetuation of the herd depends.

It has been brought to the attention of game management personnel throughout the state that there are losses of elk calves on winter game ranges and low increments of yearling elk to some herds. Therefore, detailed nutritional work with elk calves on various winter diets under controlled conditions is warranted. The immediate objectives of the study are: to determine the forage requirements, measure the effects of different diets on growth and survival, and to determine the forage preference of elk calves for various forage species during the winter.

LITERATURE REVIEW

Animal husbandry investigators have been fully aware of the merits of controlled feeding trials with domestic stock for determining the nutritive value of various forages. The many experiments that have been done are evidence that this approach is generally regarded as reliable.

The application of similar methods in the wildlife field has been limited by prohibitive costs and the lack of readily available experimental animals. Recently, however, many investigators have conducted digestion trials with deer, but only a few with elk, and in most instances, with adult elk. The nutritional requirements of elk calves are largely unknown.

Murie (1951) reports that during the winter of 1940-41 a study was conducted on the National Elk Refuge to determine forage requirements of elk. He reported that adult elk consumed an average of 2.50 pounds per hundredweight and calves ate 3.11 pounds per hundredweight over a 43 day period. The animals were fed an unrestricted diet, but the elk lost weight and ate progressively less. Olsen (1945) reported that one adult elk fed during the winter at the Utah State Fish and Game farm consumed 10 pounds of hay and 5 pounds of grain per day. He also reported that a group of seven elk were fed a ration of 11 pounds of hay per animal per day.

Hungerford (1952) found that elk calves fed meadow hay in unrestricted amounts during the winter consumed 5.83 pounds daily or 2.3 pounds of air dry forage per hundredweight. The calves lost 0.3 percent of their initial body weight during the study. He also reports forage consumption and weight response figures for adult elk fed rations of bunchgrass and browse.

Geis (1954) conducted a similar study with elk. He fed a group of five calves a diet of meadow hay during both winters of his study and reported that the calves consumed 6.75 pounds of hay daily or 2.69 pounds per hundredweight during the first year. The second year the calves ate 7.32 pounds of hay daily or 2.66 pounds per hundredweight. The calves gained weight both years.

The effects of various diets fed to the elk during a feeding trial are most easily measured in terms of weight response. Stoddard & Smith (1943) claim that weight is a sufficiently reliable index to forage requirements. However, the effects of nutritionally low rations on ultimate survival of experimentally fed elk through the winter and spring are generally unknown. Shipley & Headley (1948) claim that steers that had been retarded in growth by inadequate nutrition during a hay feeding test later, on an adequate diet, made more rapid gains than those whose growth had not been retarded.

Kidwell, et. al. (1954) report that a study was made of weight gains of range hereford cattle fed winter rations individually and in pairs or groups. They conclude that cattle, when fed a high quality hay as a group, will gain more weight than individually fed animals. Low quality hay produced no difference in gain between individuals and pairs. They based their conclusions on the fact that the individually fed animals were more restless, had a lower feed consumption, and a greater feed waste than group fed animals.

Nutritive values of native forages vary from season to season and from area to area depending upon climatic and edaphic conditions. The dry matter in the forage varies from that of a protein rich concentrate during the early vegetative stages to that of a poor roughage after maturity. Oelberg (1956) reports that the stage of maturity seems to influence forage quality more than any other factor. Protein, nitrogen free extract, ether extract, carotene, and phosphorous tend to decrease with advancing maturity whereas crude fiber, lignin, and calcium increase. The trend is more abrupt in grasses than browse.

McCall, et. al. (1943) quotes Mitchell to the effect that there is a high negative correlation between digestibility and fiber content of forages. A large amount of carbohydrates in a ration tends to depress fiber digestibility while a high concentrate of crude protein has the

opposite effect. Patton & Glosekar (1942) claim that lignin was not only indigestible, but also that it decreased the digestibility of other constituents by the mechanical effect of an indigestible encrusting material surrounding certain plant tissue.

Aldous (1945) reports that during the winter browse stems with leaves were high in protein, fat, ash, and carbohydrates and low in crude fiber. The shorter the stem, the higher was the concentrations of these nutrients. He also stated that on stems without leaves, the tip or bud ends had higher percentages of protein, fats, and carbohydrates. He concluded that where available feed is plentiful, deer tend to nip the tender tips of twigs selectively, but they take more of the stem where winter browse is limited in amount.

DeNio (1938) reports that chemical analysis shows Douglas fir and lodgepole pine are comparable to Idaho fescue in percentages of carbohydrates, fats, proteins, ash, and crude fiber. Helwig (1956) reported a similar relationship between conifers and meadow hay during the winter of 1956.

The actual nutritive value of native forages during any particular season is determined largely by the animals' preference for certain plants and for certain portions of these plants. This would indicate that a diversified plant cover would be more desirable than a single forage class.

Preference studies are quite common. Many investigators have measured the utilization of various forages during field investigations. Consequently, many browse species have received ratings as to their relative importance as food for elk, based on production and utilization. DeNio & Lommasson rated various forages found in the diets of elk during winter in the Northern Rocky Mountain region as follows: native bunchgrass, excellent to very good; serviceberry, good; snowbrush, very good; willow, fair; lodgepole pine, very poor; Douglas fir, fair (West, 1941). Cliff (1939) reported that browse plants provided the bulk of the winter food for deer and elk in the Blue Mountains of Oregon. He stated that willow and serviceberry only comprised one percent of the diet, but snowbrush made up 10 percent and Douglas fir, 3 percent. Hoskins & Dalke (1955) report observations made on the Pocatello Big Game Range that show bunchgrass made up a major portion of the winter diet of elk. Serviceberry made up 1.6 percent of the winter diet, but willow and Douglas fir were not used at all.

Gaffney (1941), in his report on the effects of elk browsing in the South Fork of the Flathead River, states that palatability of any species depends largely upon the association in which it occurs. He also states that, "the degree of consumption of various species on overbrowsed range does not give an accurate picture of palatability."

Percent utilization of current growth on study plots in the Selway was determined by Young & Robinette (1939). They found willow to be 60 percent utilized and serviceberry 40 percent. They also found that grasses were very low in relative importance to elk.

Hungerford (1952) rated willow over mountain maple and serviceberry as the most preferred browse species fed during a study conducted at the Blackfoot-Clearwater Game Range. Serviceberry was rated third. Geis (1954) reported similar results during the winters of 1953-54. Willow again ranked higher in preference than serviceberry. In the series of studies conducted by the Montana Cooperative Wildlife Research Unit, only Helwig (1956) reports on preferences between lodgepole pine and Douglas fir. He rated lodgepole pine over Douglas fir. He also found that willow was again more preferred than serviceberry.

Elk, wintering on native winter ranges, make use of the conifer browse present to some degree depending upon the condition of the range. Gaffney (1941) concludes that browsing on conifers is restricted to the overbrowsed part of the range. Schwartz & Mitchell (1945) came to the conclusion that losses of elk on west side drainages of the Olympic Peninsula resulted from malnutrition induced by eating coarse woody browse and coniferous growth. They found that 27 percent of the identified material from nine

stomach samples was conifer browse.

In Nevada, when deer are forced to eat the needles of pinon pine during the winter and spring months, it is a good indication that the range is depleted and that losses through starvation will result in time (Aldous, 1945). McCulloch (1955) reports that reproduction of tree species within the wilderness big game winter range area is generally poor. At lower elevations a definite high line is evident on Douglas fir and lodgepole pine, which is attributed to deer and elk. Conifer seedlings are infrequent and generally are stunted, hedged, or killed back by browsing. Helwig (1956) concluded from his study at the Blackfoot-Clearwater Game Range that animals which maintained their daily feed intake of conifers did not lose a significant amount of body weight.

METHODS AND PROCEDURE

The experimental facilities are located fifty miles northeast of Missoula, Montana at the Fish and Game Department's Blackfoot-Clearwater Big Game Range. This area, once known as the Boyd Ranch, comprises 50,000 acres of deeded and leased land normally used by approximately 350 to 400 head of elk during the winter.

The "pens," as they shall be called hereafter, were begun during the fall of 1951 and consisted of only four experimental units. Since then the plant has been enlarged to where it now consists of 10 experimental enclosures and a large holding corral. Four investigators have conducted nutritional studies prior to the present study.

DESCRIPTION OF THE EXPERIMENTAL SITE

The physical plant consists of 10 rectangular units 16x80 feet in size and a large holding corral. All fences were eight feet high and were made of four to six inch lodge poles. Each unit had a heavy board gate which opened to a lane leading to the weighing stall. A canvas curtained shelter occupied the far end of each pen and sawdust was spread over the ground to keep the shelter dry (Plate I).

Each pen was equipped with a wooden framed, galvanized tin hay bunk which was also sheltered from snow and rain.

Browse rails were built along the side of each rail fence. They consisted of a single pole set about six inches from the main fence. There were small roofs over the browse rails (Plate II).

Weighing facilities consisted of a Fairbanks-Morse platform scale with a box mounted on the platform. The scale was operated from inside the cabin. The lane leading from the individual pen gates divided just in front of the weighing box and animals were directed into the box and then doubled back after being released (Plate II) A series of cutoff gates and wedges kept the animals in desired locations throughout the lanes and prevented them from making runs which could result in injury. The cutoff gates were operated by a man standing in the cabin by means of a series of ropes and pulleys. Weighing facilities at the cabin were sheltered from snow.

A small, two-room cabin provided facilities for storage, working space, and housing for the investigator. Storage facilities for the browse species consisted of a roofed shelter connected with the weighing lane.

THE DIETS

The calves were fed various rations containing meadow hay, bunchgrass, willow, serviceberry, Douglas fir, and lodgepole pine. The various prescribed diets were as

follows:

1. 100% meadow hay
2. 100% bunchgrass
3. 50% bunchgrass plus unlimited amounts of conifers
4. 50% bunchgrass plus unlimited amounts of deciduous browse
5. 50% bunchgrass plus unlimited amounts of deciduous browse and conifers

Bunchgrass and meadow hay comprising the 100 percent diets of each were fed somewhat in excess of requirements so the calves could consume all they desired. The bunchgrass fraction of the remaining diets was limited to one-half the animals' requirements based on a 2.5 pounds of feed per hundred pounds of body weight. The remaining portions of the diets were fed in excess of needs.

After it became evident that the calves would not eat the coniferous species when deciduous species were present, two groups of calves were provided with only one species of coniferous browse plus the prescribed amounts of the other forages in an attempt to attain utilization of some conifers. These diets containing both deciduous and conifer browse resulted in a diet of 50 percent bunchgrass and 50 percent deciduous browse throughout most of the study.

All the diets were replicated by pen in groups of two with four calves on a particular diet. The 100 percent bunchgrass and the 100 percent meadow hay diets were not

replicated by pen, but three and four calves were fed these rations respectively.

The diets prescribed for the 1958 study were identical to the previous year, but no replication was done as only 10 elk were used in the study. The diet composed of 50 percent bunchgrass plus deciduous browse plus conifer browse was deleted from the study. The 100 percent hay and 100 percent bunchgrass diets were altered to provide data on feed intake of animals fed as single or isolated calves.

FEEDING METHODS

Hay and bunchgrass were presented to the elk in the sheltered hay bunks. The bunks could accomodate about 25 pounds of material well mixed without being scattered by the elk. The browse species were wedged between the browse rails and the main fence so that the terminal portions of each bundle projected up and in toward the center of the pen in a nearly natural position (Plate III).

All feed was weighed to 1/10 of a pound by means of a Hansen dairy scale before it was given to the elk. It was also weighed when recovered the next day. The difference, feed intake, was recorded for each diet component on a daily feed intake form.

FEEDING SCHEDULE

The elk were subjected to a set schedule of feeding. Each morning at approximately nine o'clock the feeding began with the unused portions of the previous day's feed being collected, weighed, and discarded. Each pen was worked progressively and a new ration of browse species was provided as soon as the old was removed. After all the pens had been worked in this manner the bunchgrass or hay was given to the elk. The delay in presenting the most palatable feed provided the animals with an opportunity to consume a portion of their requirements of the least desirable feed. When the schedule was interrupted the calves became noticeably nervous.

WATERING

Water was made available each day immediately after the feeding schedule was completed. The water had to be carried from a small stream which flows behind the physical plant and then placed in 14 quart pans in the pens. No records were kept of water consumption.

SALT

Salt was made available to all the elk throughout the entire study. A coffee can filled with salt was nailed to each hay bunk. No attempt was made to measure amounts

taken from day to day or during the study. The cans were refilled if they became empty.

ANIMAL PROCUREMENT

Twenty-one elk calves of either sex were secured for the 1957 study by the personnel at the game range. Four calves trapped on December 7, 1956 were the first to be released and held in the corral at the pens. One more was trapped on December 24, six on December 27, one on January 5, 1957 and six more the 9th, two on the 10th, and the last one was trapped January 12. Later in the month of January, 17 calves were trucked from Yellowstone Park to the pens. Only three calves from this group were used in the study, but the remaining calves were held in the corral primarily as replacement material and as a buffer between weekend visitors and the study animals (Plate IV).

All the calves used during the 1958 study were trapped locally and none were obtained from Yellowstone Park. Only 10 calves were used in the study, all being received at the pens by January 15.

FORAGE COLLECTION

Bunchgrass, (Agropyron spicatum and Festuca scabrella), was collected during the month of November, 1957 from the Blanchard Flats area of the Game Range adjacent to the Seely

Lake highway. It was harvested by means of a conventional power mower set approximately four inches above the ground. The mower bar was fitted with a catch-pan device which kept the grass in easy-to-handle piles. The material was hauled to the Game Range headquarters, baled, and stored under shelter until it was used in the feeding study.

The meadow hay fraction of the study diets was procured from the Game Range supply. It was cut from the native hay meadows of the Game Range during the summer months, baled, and stored under shelter at the range headquarters. The hay consisted of timothy, redtop, sedges, and clover. The investigator had free choice in securing bales to use for the study and only those bales appearing to be of fine textured material were selected. This tended to reduce the coarse stemmed timothy in the hay diets.

Each week a supply of hay and bunchgrass was hauled from the storage facilities at the headquarters to the pens and stored in the cabin.

Conifer browse was cut from the Tote Road area of the Game Range. Lower branches were cut and tied in bundles containing from five to six branches. Fresh material was cut weekly by the investigator and his assistant and hauled to the pens and covered with waterproof canvas.

The deciduous browse was cut on the Evaro Hill area of the Flathead Indian Reservation on Saturdays by student

labor and hauled to the pens on the following Monday by the Game Range personnel. Upon arrival at the pens the browse was piled under the browse shelter. This was essentially the procedure followed in the previous years of the elk nutrition studies.

Forage collection for the 1958 study was accomplished in the same manner as in the previous year with exception of the hauling of the deciduous browse. It was transported to the pens the day after cutting. Bunchgrass was cut a month earlier than the previous year.

ADJUSTMENT OF THE ELK CALVES

Upon arrival at the pens prior to initiation of the 1957 study, the calves were held in the corral for a few days and fed hay until they became accustomed to being penned. They were then weighed, marked, and placed in groups of four calves each in the study pens. For a period of five days they were fed a diet of all the meadow hay they desired. The elk were then paired according to weight and fed a diet consisting of all the food species to be used throughout the study. Snowbrush (Ceanothus velutinus) was available only during this free choice period.

The free choice diet progressed for eight days and every other day the foods not prescribed for certain calves were slowly diminished until, at the last day, the calves

were being fed the food species prescribed and in the set proportions. The pairs of calves remained in their initial pens throughout the study.

The elk were treated in the same manner the second year of the study, but no free choice diet was presented. An 11 day period of 100 percent meadow hay was fed to all of the elk prior to their going on prescribed diets. The change from hay to prescribed diets was therefore very abrupt in most instances. The abrupt change was made to measure the response of the calves to a completely new diet.

No attempt was made to pair the animals according to sex; however, they were paired according to weight. This tended to eliminate any dominance of a large animal over a smaller one.

FEED INTAKE RECORDS

A continuous record was kept from day to day of the feed intake for each pen of animals. This insured prompt awareness of any changes in forage consumption. The records were converted to an air dry weight value upon completion of the study.

AIR DRY WEIGHTS OF FORAGE

Every three days a sample of each type of feed was taken for air dry weight analysis. The samples were usually

taken in 100 gram weights, placed in paper sacks and hung in the heated cabin for nine days. They were then moved to the feed storage rooms where they remained for another nine days to adjust to a reference air dry moisture content. The air dry weight of each sample was recorded to 1/10 of a gram as a percentage. After the air dry weight was determined, a small sample from each bag was taken and saved for chemical analysis.

ANIMAL RESPONSE

The elk were weighed at two-week intervals throughout the study to determine weight changes (Plate IV). This provided the principal basis for elk winter diet evaluation. At the time of weighing the animals were also checked for general behavior and condition.

WEATHER RECORDS

Weather data was collected at noon each day. Temperatures were recorded with a maximum-minimum thermometer and a thermograph. Wind velocity was recorded by anemometers, one recording on a drum recorder and the other on a 1/60 of a mile counter. Snow accumulation was measured with a meter stick.

FECAL COLLECTION

Fecal collections were made every three days and the samples were preserved in glass jars containing a small amount of toluene to prevent bacterial decomposition. All samples were mixed and ground and a small amount of each was sent, along with the forage samples, to the State Agricultural Experiment station for chemical analysis.

RELATIVE DIGESTIBILITY OF THE FEEDS

Relative digestibility was computed by means of the lignin ratio method, the following formula being employed:

$$\% \text{ Digestibility of a feed} = 100 - 100 \frac{\% \text{ Lig. in feed}}{\% \text{ Lig. in feces}} \times \frac{\% \text{ non Lig. in feces}}{\% \text{ non Lig. in feed}}$$

FORAGE CONSUMPTION AND WEIGHT RESPONSE

RESULTS WITH 100 PERCENT MEADOW HAY

Summaries of the results of the two year study for all diets are shown in Tables 1 and 2.

During the first year of the study, four calves were fed, as a group, a ration consisting of 100 percent meadow hay. The calves were of mixed origin, three being from Yellowstone Park and the other was from the local Game Range herd.

Daily consumption was quite variable throughout the study as shown in Figure 1. There was no apparent cause for this fluctuation; however, the results of other studies show that this daily fluctuation is normal. Average consumption over the 56 day period was 2.57 pounds per hundredweight per day, which compares closely with previous hay consumption data of elk calves, which was 2.3, 2.66, and 2.69 pounds per hundredweight per day during the winters of 1952, 53, and 54. Previously, however, during the winter months the calves gained weight on a hay diet with consumption in excess of 2.3 pounds per day. These four calves lost an average of 3.7 percent of their initial body weight over the entire 56 day feeding period.

Figure 2 shows that comsumption was relatively low the

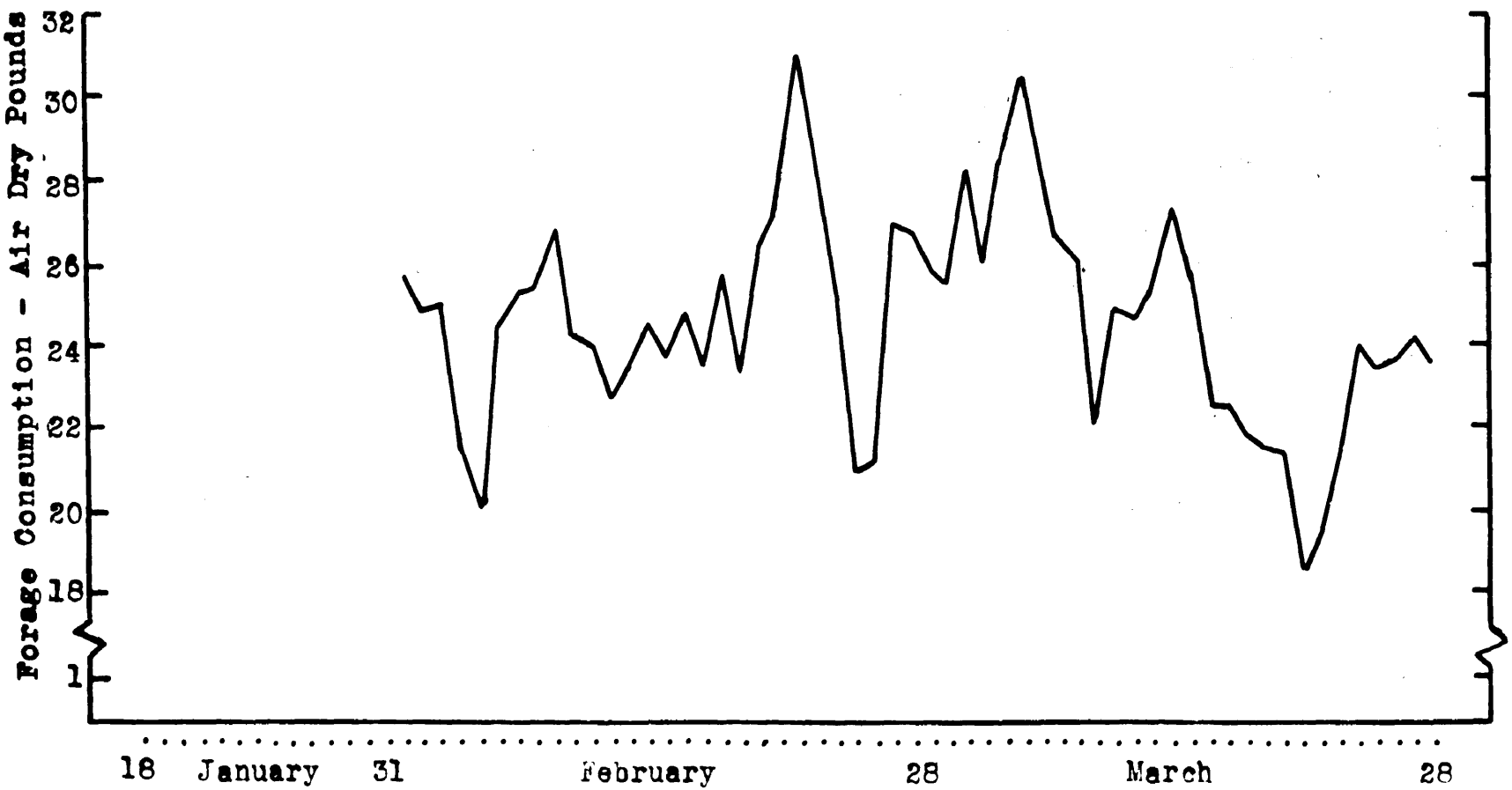


Figure 1. - 1957 daily forage consumption for four elk calves fed a diet of 100 percent meadow hay.

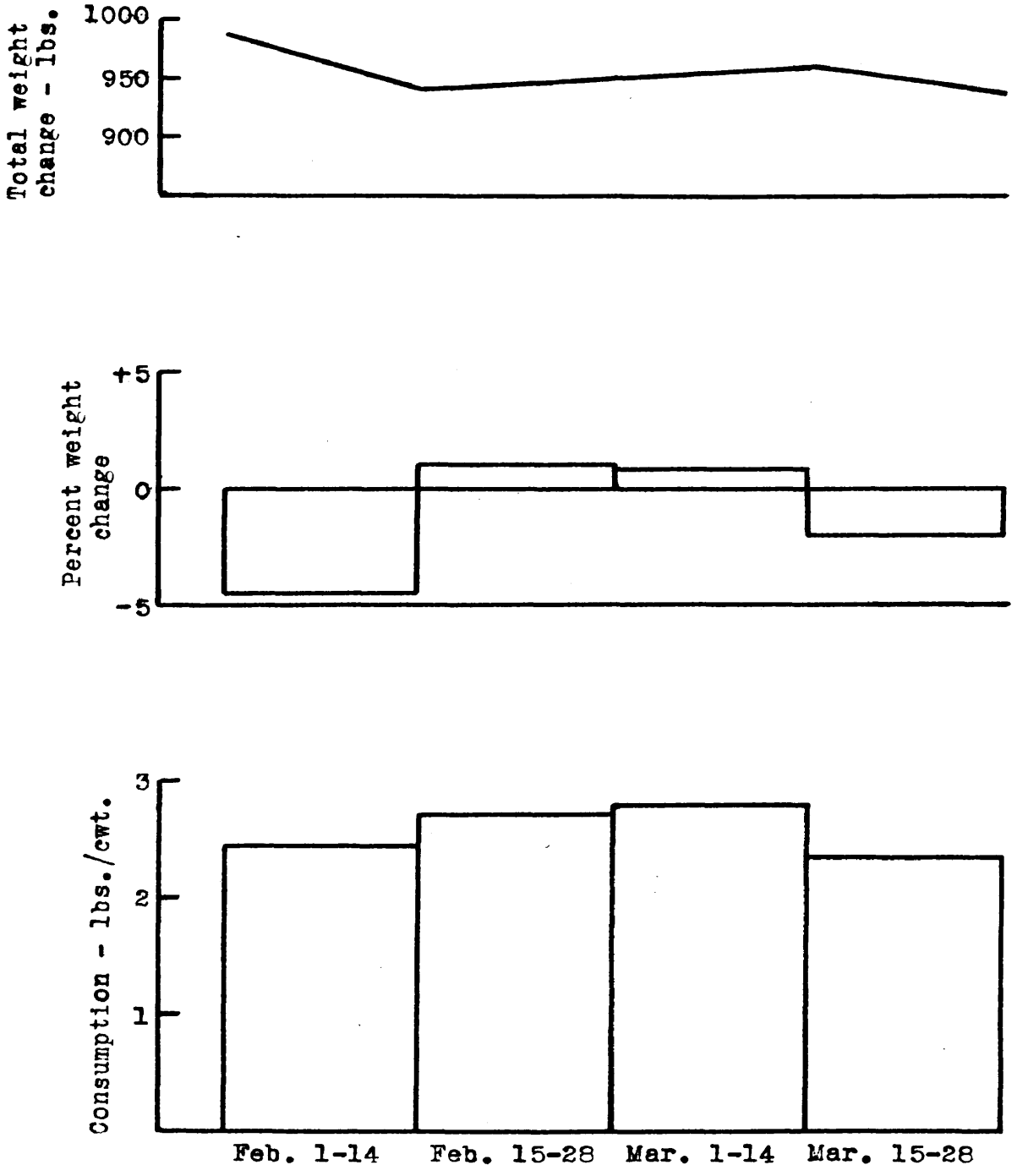


Figure 2. - 1957 Forage consumption and weight response by two week periods of four calves fed a diet of 100 percent meadow hay.

first two-week period of the study, being only 2.45 pounds per hundredweight. This produced a weight loss of 4.5 percent. Thereafter as consumption increased above the 2.5 pound level, weight also increased. The food intake during the last two-week period, although much lower than the first two weeks, resulted in only a small weight loss. The effects of the previously high consumption presumably carried over to the last two weeks.

During the adjustment period of the 1958 study, all the calves were fed a 100 percent meadow hay ration for 11 days. Records were kept of consumption and weight response for this period. The calves consumed an average of 2.51 pounds per hundredweight per day and gained 2.16 percent of their initial body weight.

The meadow hay diet during the study period was altered to give data on the effects of isolation on consumption and weight response. Two calves were fed separately for a period of 28 days. These calves ate less than those fed in a group, consuming 2.03 and 2.11 pounds per hundredweight per day. They lost 2.46 percent and gained .21 percent of their initial weight respectively. Figure 3 shows that consumption was relatively stable throughout the 28 day period with one instance of abrupt drop in feed intake. This was due to injury to the animal's mouth during the weighing operations. Figure 4 shows the relationship between consumption and

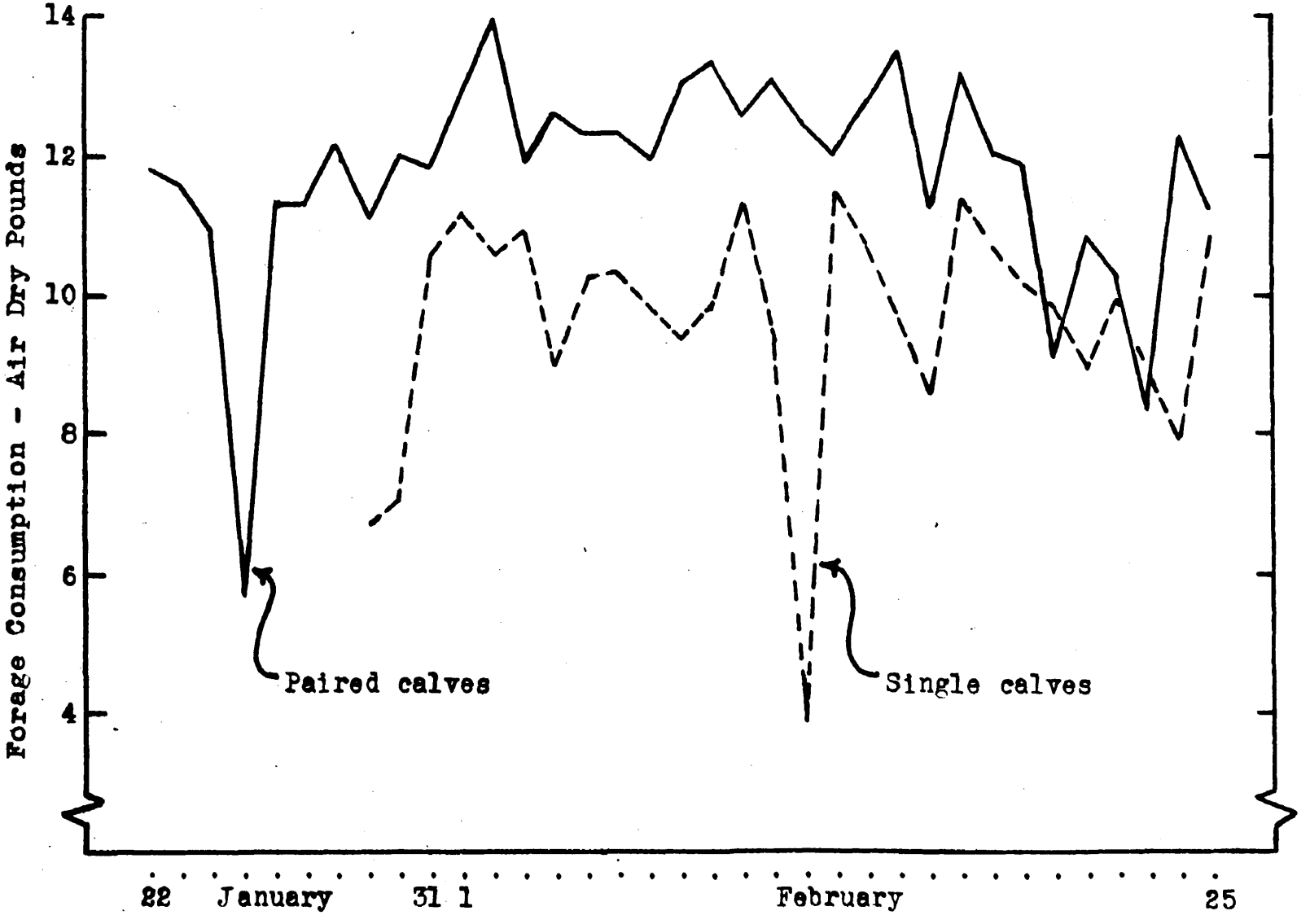


Figure 3. - 1958 daily forage consumption of a pair of elk calves and two single calves fed a diet of 100 percent meadow hay.

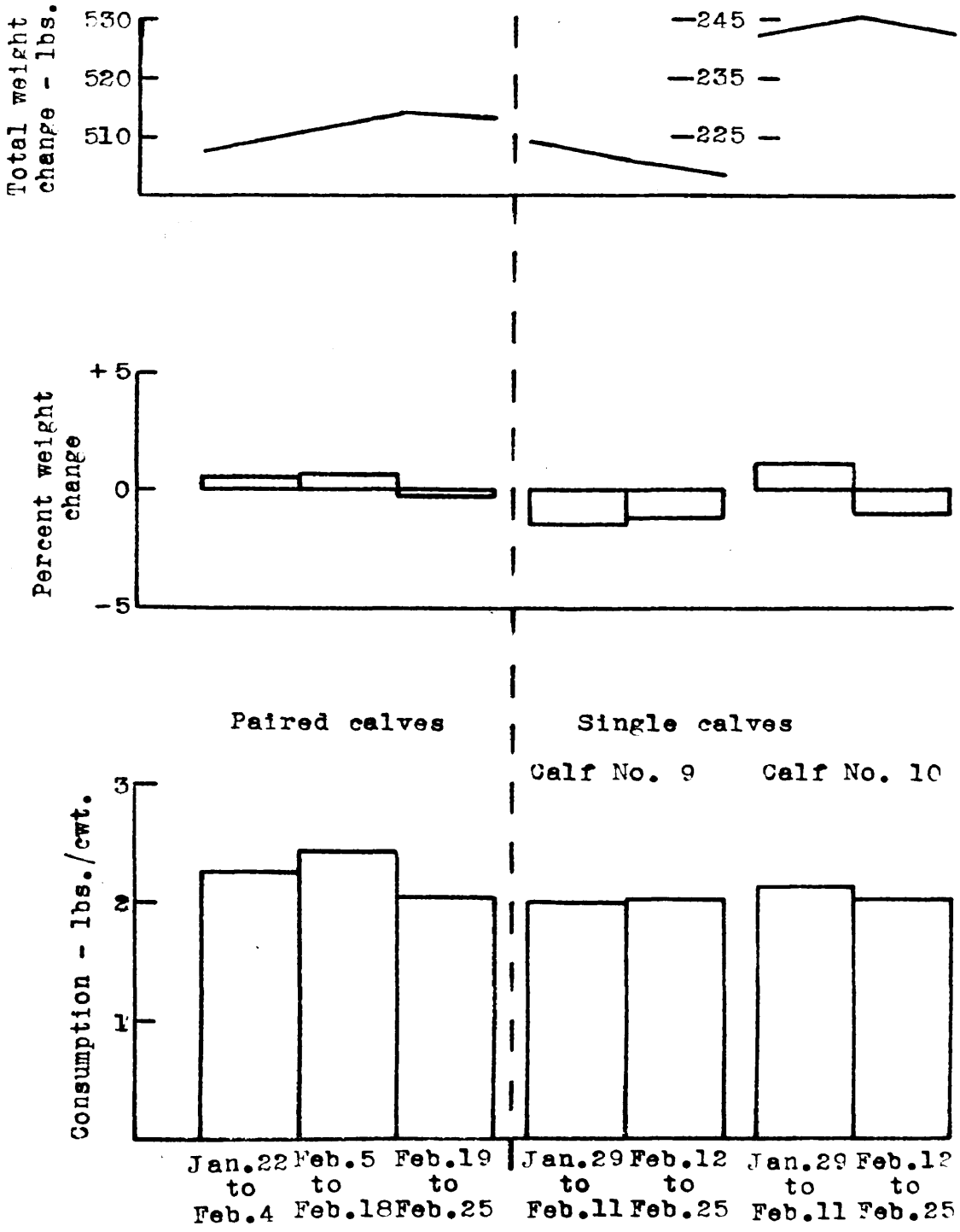


Figure 4. - 1958 forage consumption and weight response by two week periods of a pair of elk calves and two single calves fed a diet of 100 percent meadow hay.

weight response for the isolated calves.

During the 1958 study, two animals were grouped together and fed meadow hay. Daily consumption for the paired animals was quite steady as shown in Figure 3. Fluctuations of high magnitude occurred only at the beginning and end of the 35 day period. Consumption for the paired animals amounted to an average of 2.29 pounds per hundredweight per day. This was .3 of a pound lower than the consumption value of the previous year. However, the animals gained weight on this diet in 1958, whereas they lost weight on the same diet in 1957.

The consumption of forage necessary to produce a gain in weight was much lower in 1958 than the previous year. Figure 4 shows that only 2.25 pounds per hundredweight produced a gain of .6 percent; however, an increase in consumption to 2.43 pounds per hundredweight only produced a gain of .1 percent over the previous period.

RESULTS WITH 100 PERCENT BUNCHGRASS

Four elk calves were started on this diet at the beginning of the 1957 study period; however, one of the elk died after one month. A post-mortem of this animal indicated that it had died of starvation, the bone marrow being pink and jelly-like. Further investigation revealed that the

calf had been injured during the trapping operations which probably caused it to feed abnormally. This animal lost 30 percent of its initial body weight before succumbing.

Daily bunchgrass consumption started at a relatively high level and rapidly declined throughout the 70 day period with a slight increase toward termination of the study. See Figure 5 for a graphic representation of the data. It appears from the graph that the sick animal had not been consuming appreciable amounts of forage. When it died, feed intake did not make an abrupt drop.

Figure 6 indicates that after the calves attain a poor condition a general "leveling-off" is achieved. The calves continued to eat less as the study progressed with the least consumption occurring during the last two weeks. Weight loss during the final two weeks, however, amounted to .7 percent as compared to 7.4 percent the previous two-week period.

During the 70 day study period the calves ate an average of 1.54 pounds per hundredweight per day and lost an average of 15 percent of their initial body weights. Cow elk fed a comparable diet during the winters of 1952, 53, and 54 ate more bunchgrass per hundredweight and also lost less of their initial body weight.

The second year of the study, two calves were started on a 100 percent bunchgrass diet; however, after 17 days they

Figure 5. - 1957 daily forage consumption of four elk calves fed a diet of 100 percent bunchgrass.

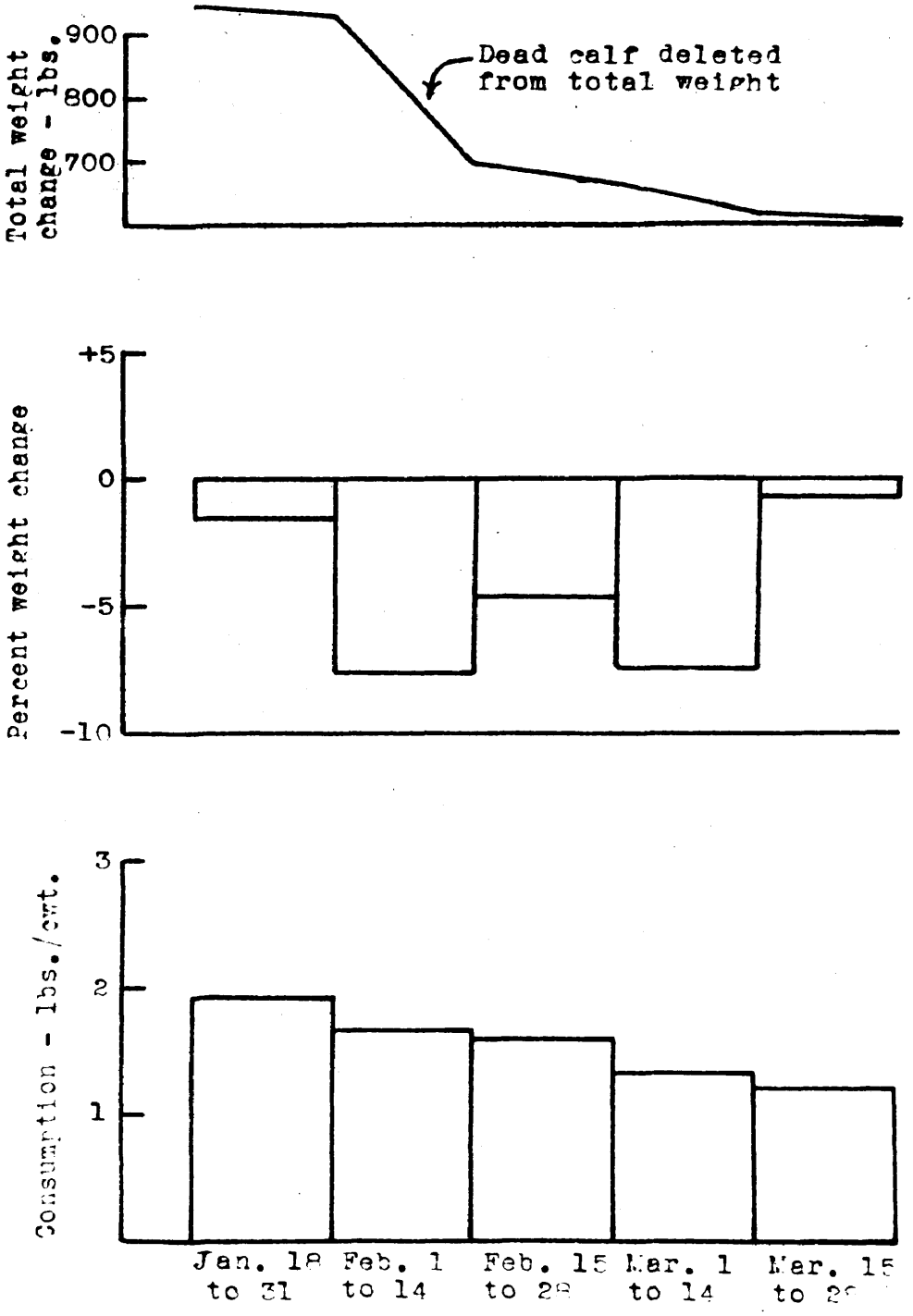


Figure 6. - 1957 forage consumption and weight response by two week periods of four elk calves fed a diet of 100 percent bunchgrass.

were separated because feed intake declined at a rapid rate. One of the calves lost 33 pounds the first two weeks of the study. Figure 7 shows graphically the daily forage consumption for the elk when paired and also after separation.

Consumption for the paired calves during the first 17 days amounted to 1.43 pounds per hundredweight per day with a weight loss of 10.7 percent over initial body weight. The separated calves continued on the bunchgrass diet for the remainder of the study, however, and amazing results were obtained with the calf which had lost the most weight previously. This particular calf, number 2, consumed an average of 1.94 pounds per hundredweight per day and regained .23 percent of its body weight from its lowest level. The other calf consumed 1.35 pounds per hundredweight per day and lost 17 percent of its weight over the entire 35 day period. See Figure 8 for the relationship of consumption to weight response for the animals paired and singly.

RESULTS WITH 50 PERCENT BUNCHGRASS PLUS DECIDUOUS BROWSE

During the 1957 study period, four elk calves were fed a diet consisting of a limited amount of bunchgrass plus all the deciduous browse, willow, and serviceberry they wished to consume. The browse was offered in nearly equal amounts well in excess of the animals' estimated needs. The bunchgrass portion of the diet was fed on the basis of 2.5

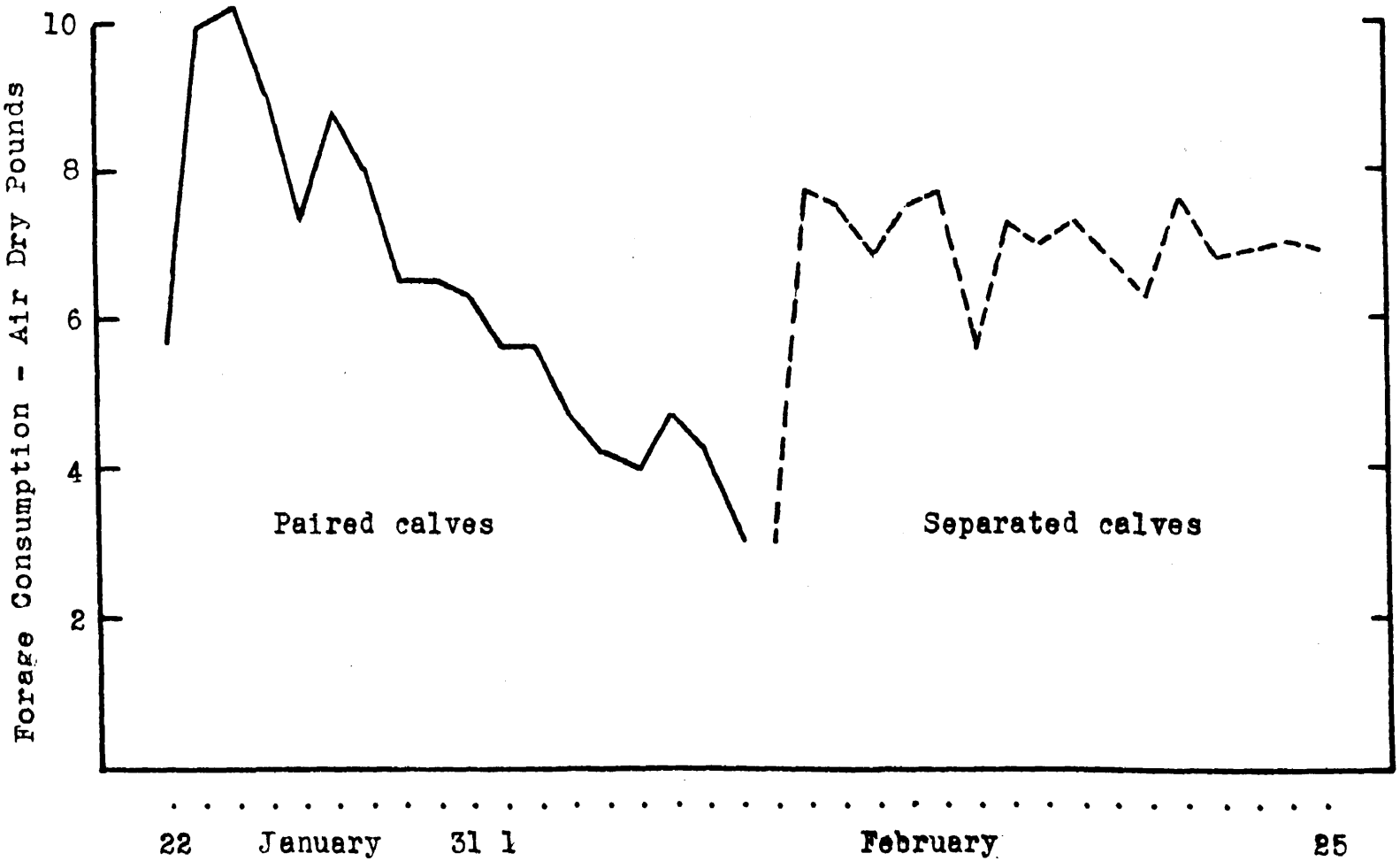


Figure 7.- 1958 daily forage consumption of two calves fed first as a pair and later separated on a diet of 100 percent bunchgrass.

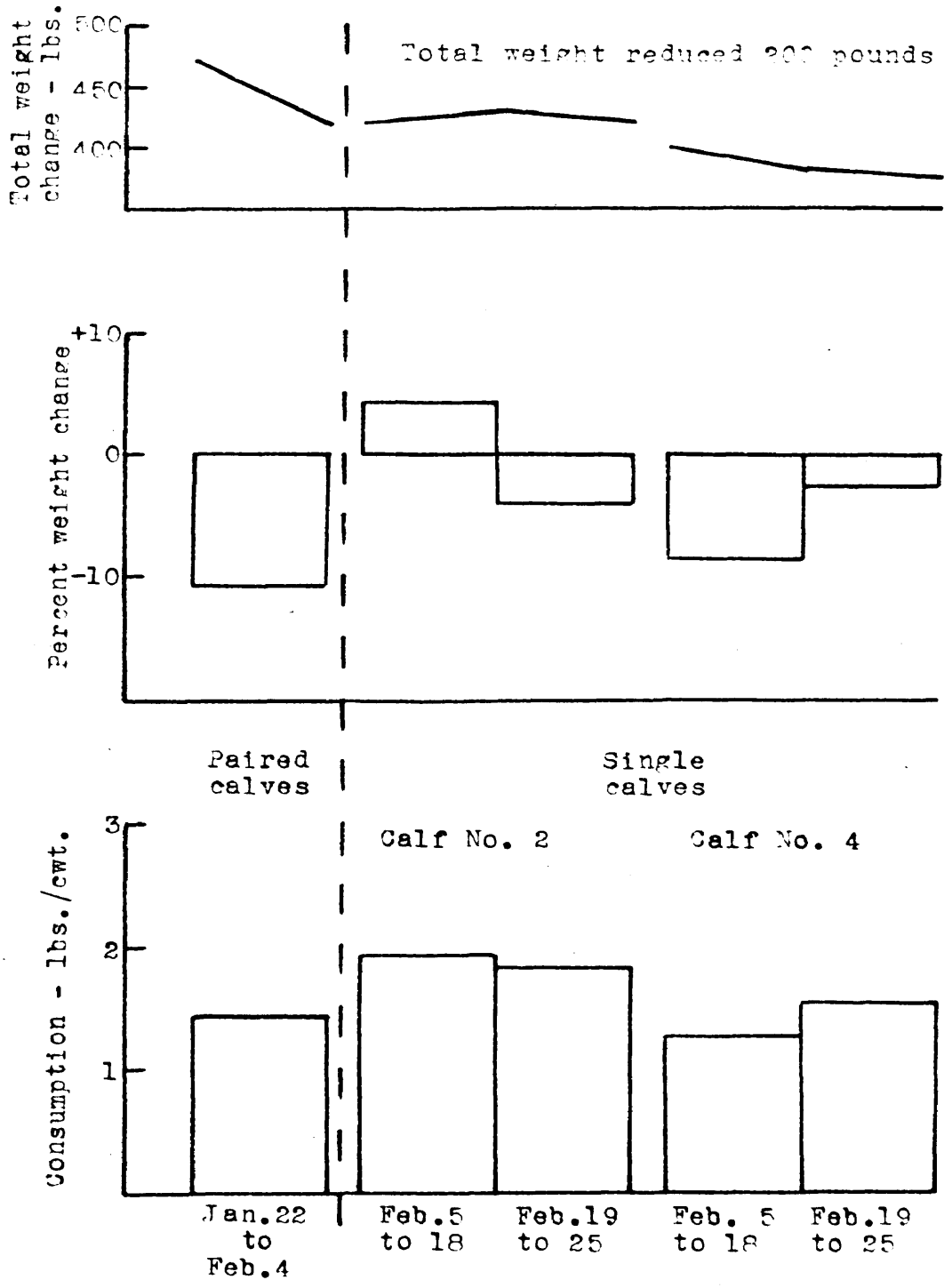


Figure 8.- 1958 forage consumption and weight response by two week periods of two calves fed first as a pair and later separated on a diet of 100 percent bunchgrass.

pounds per hundredweight per day and reduced to a half ration.

The calves consumed almost equal amounts of each forage class, but evidently not enough of both as weight loss occurred throughout the study. The elk consumed an average of 2.01 pounds per hundredweight per day with the greatest consumption occurring the second two-week period. See Figure 9 for graphic representation of this data.

Figure 9 illustrates three instances of no use of either serviceberry or willow. This was a result of unavailability of the particular browse species due to depletion of the weekly supply and not a matter of refusal by the calves. In all but one instance the daily requirement was made up of the remaining single browse species.

The calves lost 11.5 percent of their initial weight during the 70 days. Figure 10 shows that as consumption declined at a fairly steady rate, the weight likewise declined steadily. Although the calves gained weight during the first two-week period, they consumed less forage than during any other period. This may be explained by the fact that the calves were increasing their consumption rapidly from a very low level during the first few days.

Only two calves were fed this particular diet during the second year of the study. Forage consumption amounted to 2.06 pounds per hundredweight per day throughout the 35

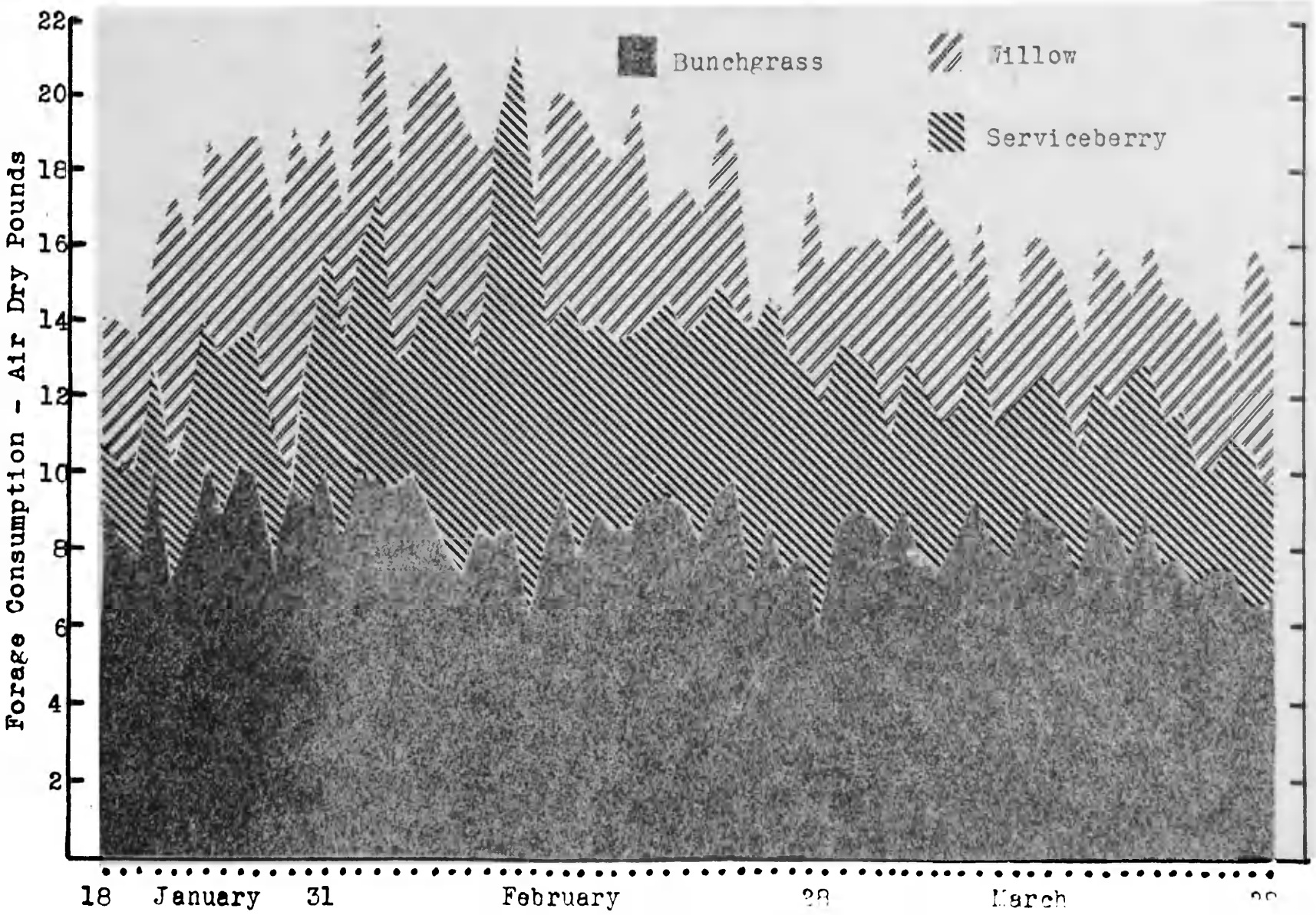


Figure 9.- 1957 daily forage consumption of four elk calves fed a diet of 50 percent bunchgrass plus deciduous browse.

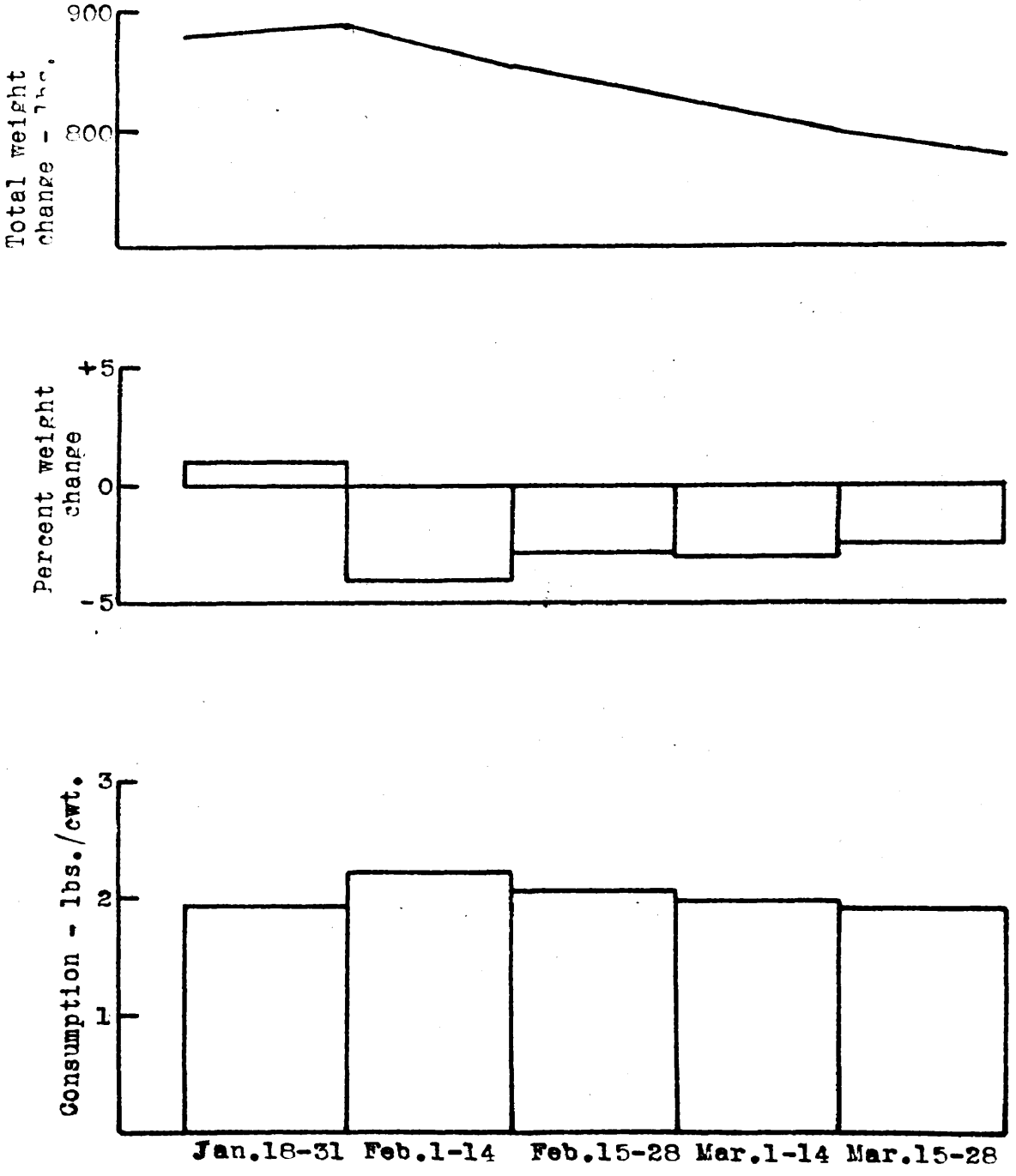


Figure 10.- 1957 forage consumption and weight response by two week periods of four elk calves fed a diet of 50 percent bunchgrass plus deciduous browse.

day period with a loss in weight of 6.64 percent from their initial body weight. Daily forage consumption was fairly uniform throughout the study, especially consumption of the bunchgrass fraction, which hardly fluctuated at all. See Figure 11 for graphic representation of daily feed intake.

Figure 12 shows the relationship of consumption to weight response. Forage consumption the first two-week period was lower than the second period. This relationship is true of all diets during the second year of the study except in the case of the meadow hay diets. The animals also showed a heavy weight loss during this period. This indicates that the abrupt change from one type of feed to an entirely different type without a so-called "break-in" period may have an adverse effect upon the elk calves.

RESULTS WITH 50 PERCENT BUNCHGRASS PLUS CONIFERS

Four calves, in two pairs, were fed a ration consisting of 50 percent bunchgrass plus conifer browse during the 1957 study. The calves ate only an average of 1.43 pounds of forage per hundredweight per day and lost a large percentage of their initial weight, 14.2 percent. Figure 13 shows that initially feed intake was quite high, but quite variable in consumption of conifers. Bunchgrass consumption remained constant for approximately five weeks and then fluctuated during the remaining five weeks with conifers comprising

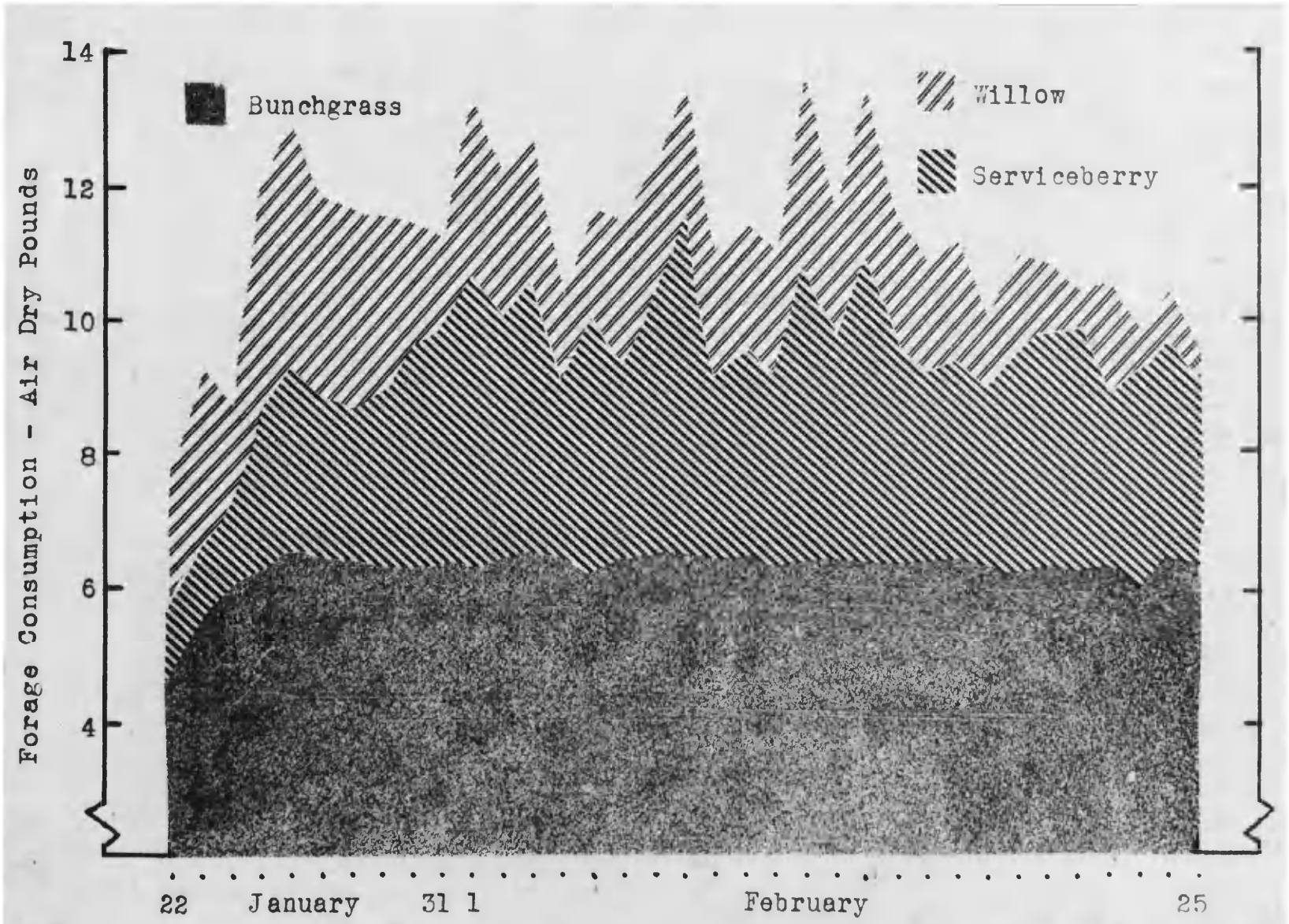


Figure 11.- 1958 daily forage consumption of a pair of elk calves fed a diet of 50 percent bunchgrass plus deciduous browse.

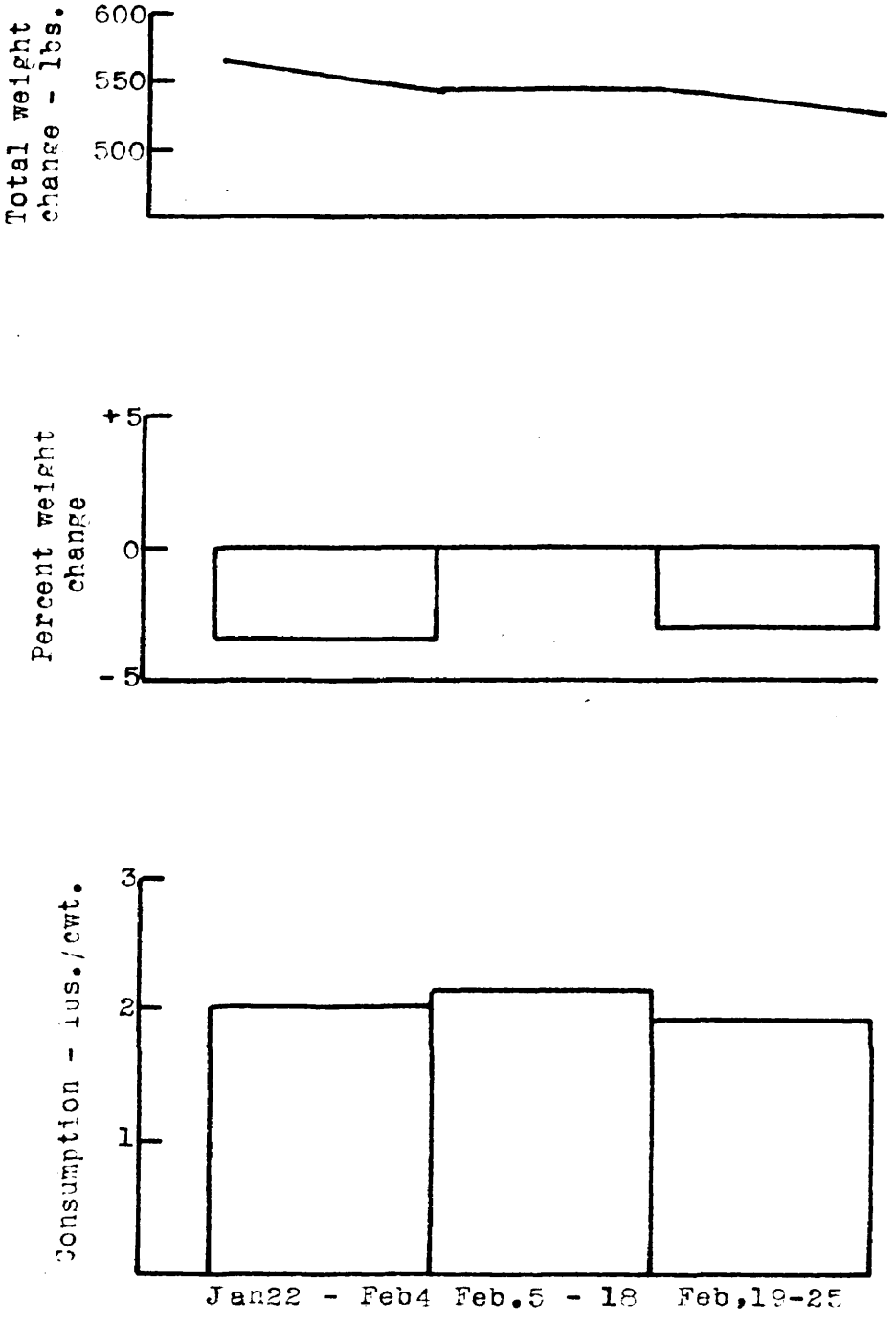


Figure 12.- 1958 forage consumption and weight response by two week periods of a pair of [illegible] 50 percent bunchgrass plus deciduous browse.

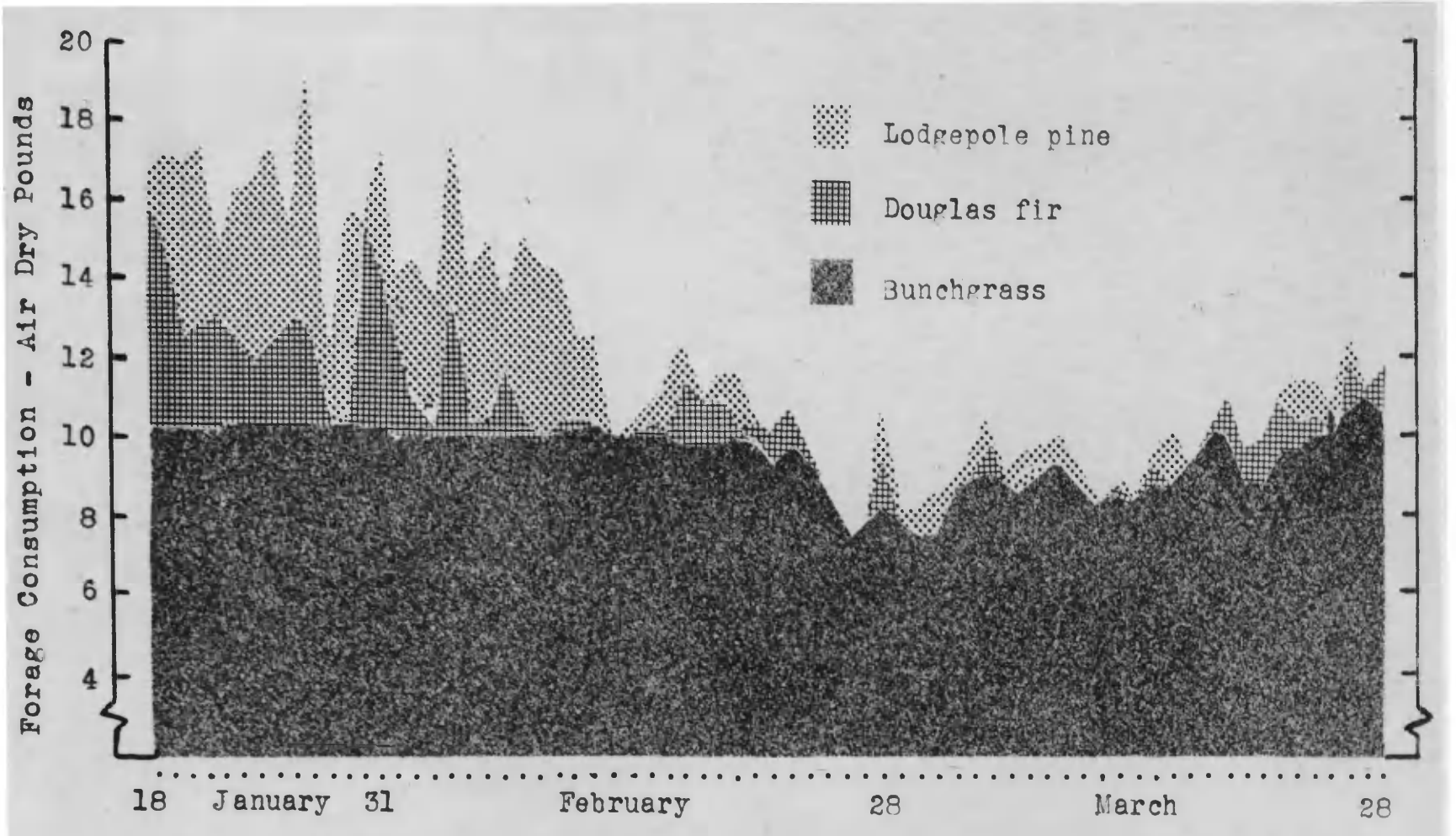


Figure 13.- 1957 daily forage consumption of four elk calves fed a diet of 50 percent bunchgrass plus conifers.

only a small percentage of the total diet during the last five weeks.

The two pairs of animals on the diet were quite different in their behavior. The two animals in Pen No. 2 would eat hardly any conifers and consumption of forage dropped to an extremely low level. They had to have a supplemental one pound of meadow hay per day added to their diet the last two weeks of the study as it was doubtful whether they could have survived otherwise. The animals in Pen No. 9 maintained their conifer consumption at a fairly high rate. They would also attempt to acquire some deciduous browse from the adjoining pen even though much canvas was nailed to the fence to prevent this. They did get some deciduous browse, but not regularly and in very small quantities. These two calves in Pen No. 9 lost only 10.2 percent of their initial body weight, which would indicate that if forage consumption is maintained on any of the diet combinations tested, the decline in weight or animal condition will be relatively small.

Figure 14 shows the relationship of forage consumption to weight response for all the calves on this particular diet. The calves reacted to this diet in much the same manner as the calves fed deciduous browse and lodgepole pine. As consumption increased toward the termination of the study, the animals lost less weight.

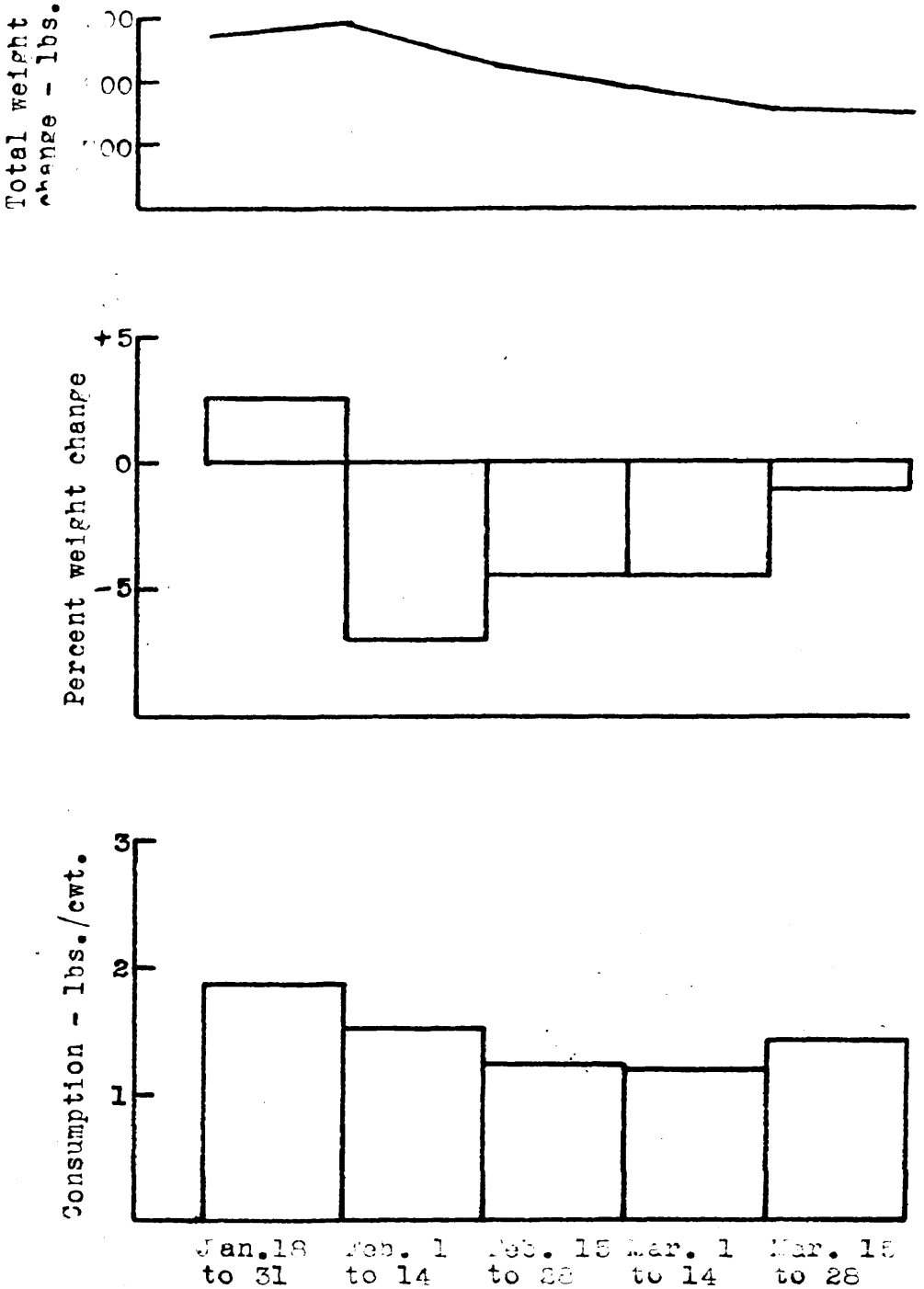


Figure 14.- 1957 forage consumption and weight change by two week periods of four elk calves fed a diet of 50 percent bunchgrass plus conifers.

The two calves fed this ration during the 1958 study produced results which were nearly opposite from the previous year except that animal condition also declined this year. The calves ate an average of 1.72 pounds of forage per hundredweight per day during the 35 day period and lost 10.33 percent of their initial body weight. Figure 15 shows graphically that daily consumption was quite uniform throughout the study, especially for bunchgrass. Conifer intake fluctuated during the entire study, with Douglas fir being more heavily used for the first three weeks. However, the last two weeks the Doublas fir was neglected in favor of the lodgepole pine.

Figure 16 shows the relationship of consumption to weight response. As was the case of all diets during the 1958 study which didn't contain meadow hay, the feed intake the first two-week period was the lowest, with the greatest percentage of weight being lost. Thereafter the consumption increased and weight declined at a diminishing rate.

RESULTS WITH 50 PERCENT BUNCHGRASS PLUS DECIDUOUS BROWSE PLUS CONIFERS

A diet consisting of bunchgrass plus deciduous browse and conifer browse was included in the 1957 study period to measure the effects of this type of diet on elk calves. It was hoped that the calves would consume appreciable amounts of the conifers along with the other diet components so that

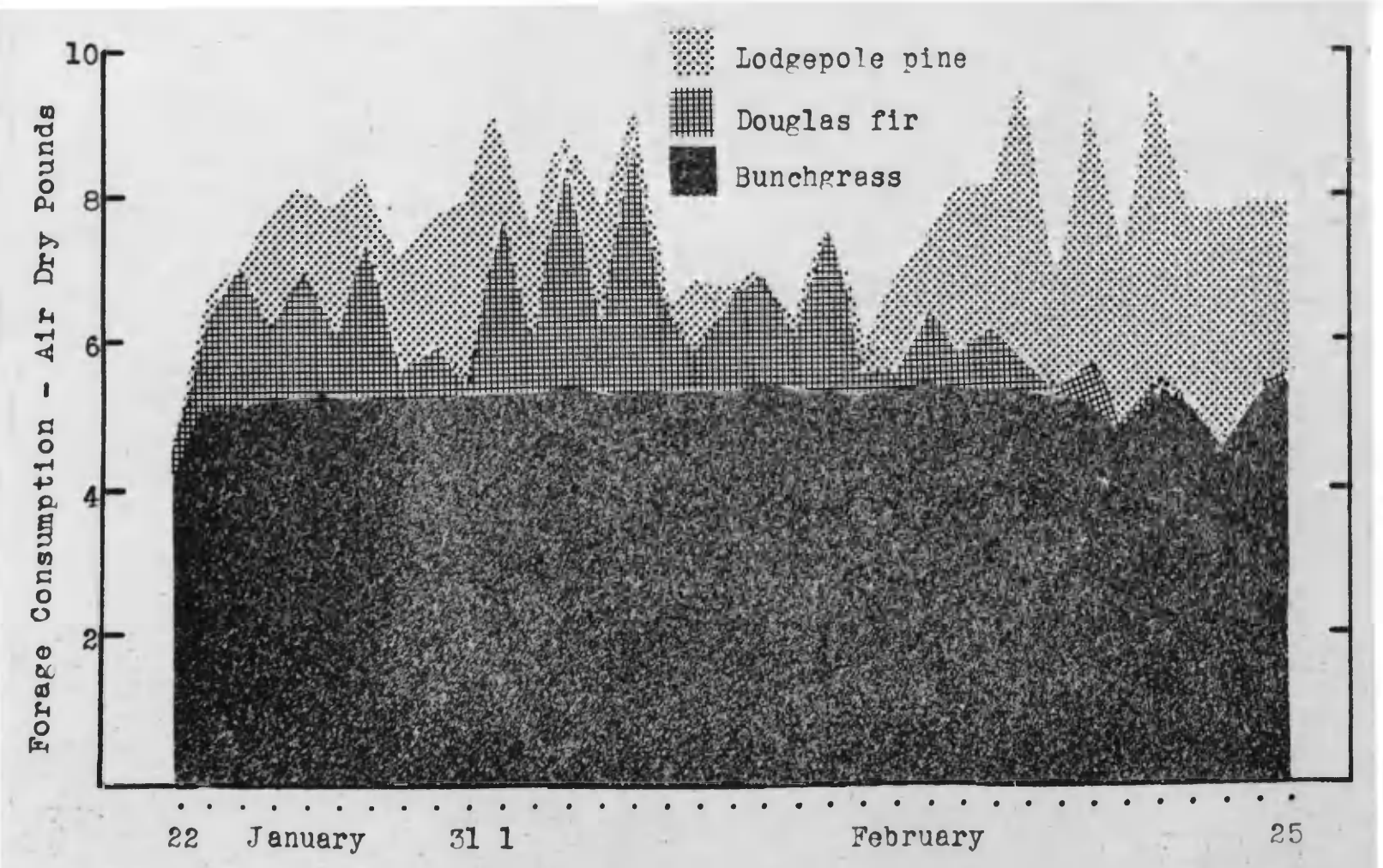


Figure 15.- 1958 daily forage consumption of a pair of elk calves fed a diet of 50 percent bunchgrass plus conifers.

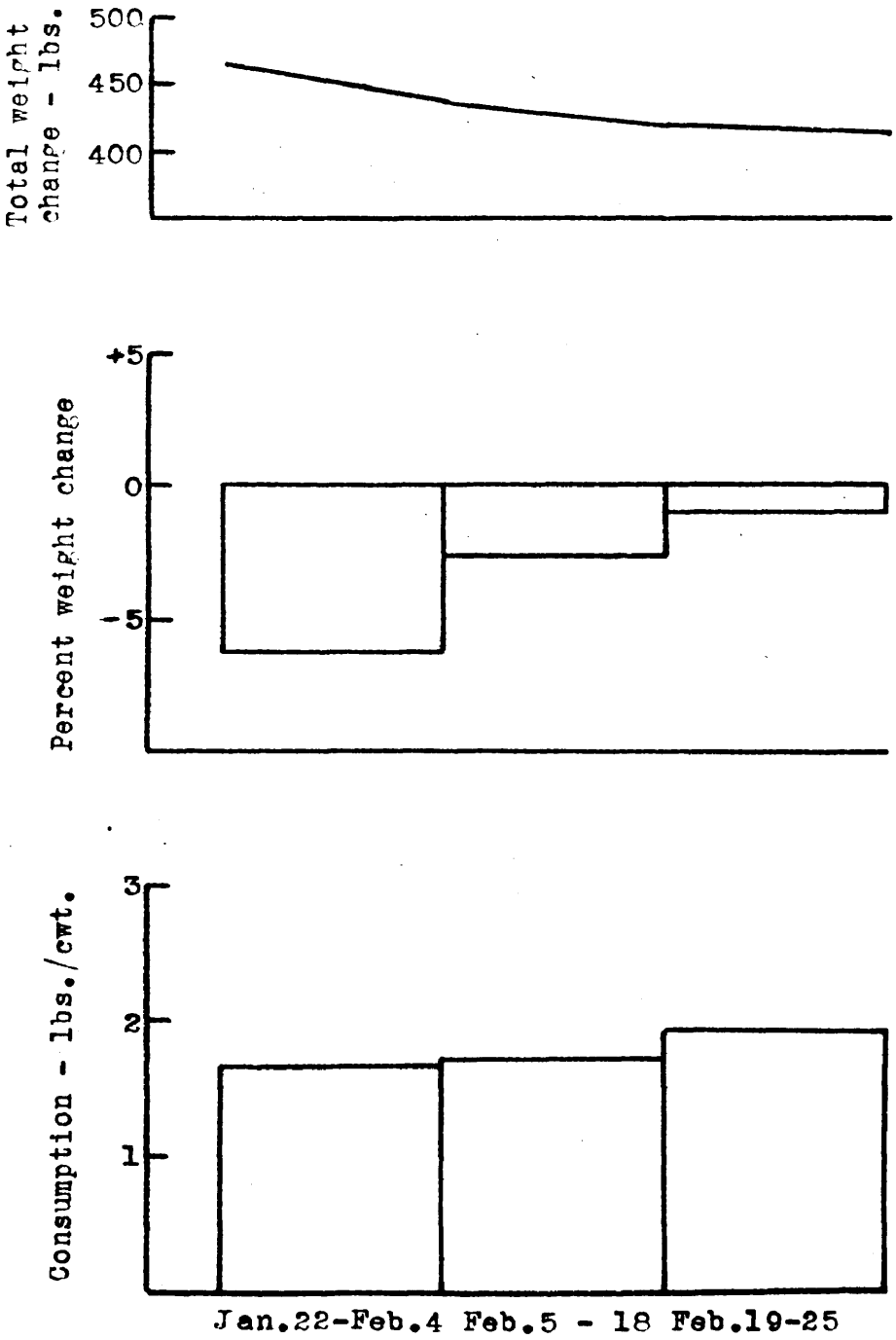


Figure 16.- 1958 forage consumption and weight response by two week periods of two calves fed a diet of 50 percent bunchgrass plus conifers.

significant results could be obtained for this type of diet; however, the calves refused to eat the conifers throughout most of the study and therefore were consuming a diet composed basically of bunchgrass and deciduous browse.

Eight calves were started on this type of diet, but when it became evident that conifers were being overlooked in favor of the more palatable browse, two pens were altered and supplied with only a single species of conifer browse in an attempt to secure consumption of at least one conifer component. However, only small amounts of conifers were consumed by either pair when offered only one species of conifer along with the other dietary components.

Bunchgrass consumption was more irregular although the amount was limited, the animals preferred to satisfy their requirements with more of the deciduous species. See Figure 17 for daily consumption of all classes of forage.

Average daily consumption amounted to 1.96 pounds per hundredweight per day with a decrease in body weight of 13.9 percent. All the calves responded uniformly to the diet, all losing approximately the same percentage of body weight. Figure 18 shows the relationship of consumption to animal response.

This diet was not repeated during the 1950 study due to poor results in achieving conifer utilization.

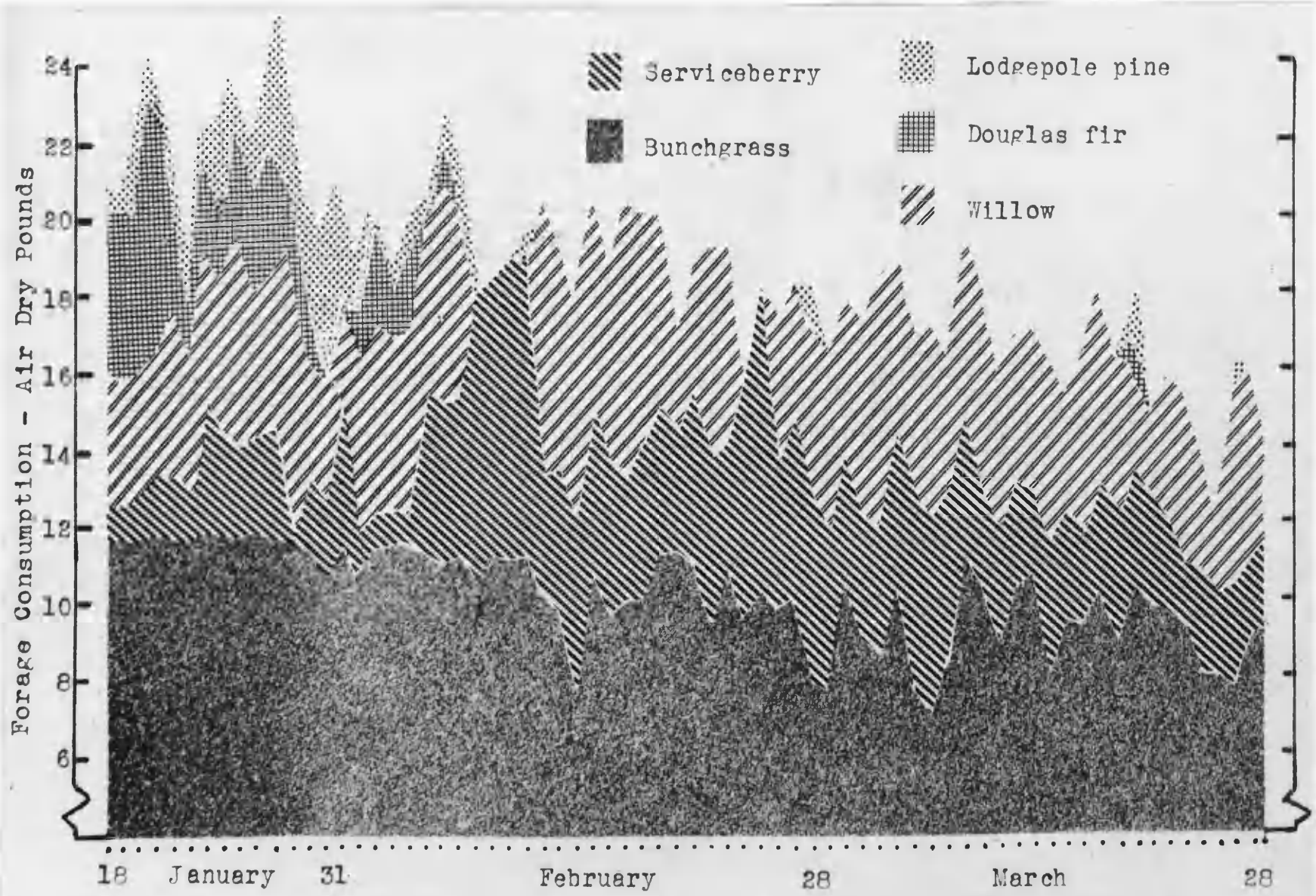


Figure 17.- 1957 daily forage consumption of four elk calves fed a diet of 50 percent bunchgrass plus deciduous browse plus conifers.

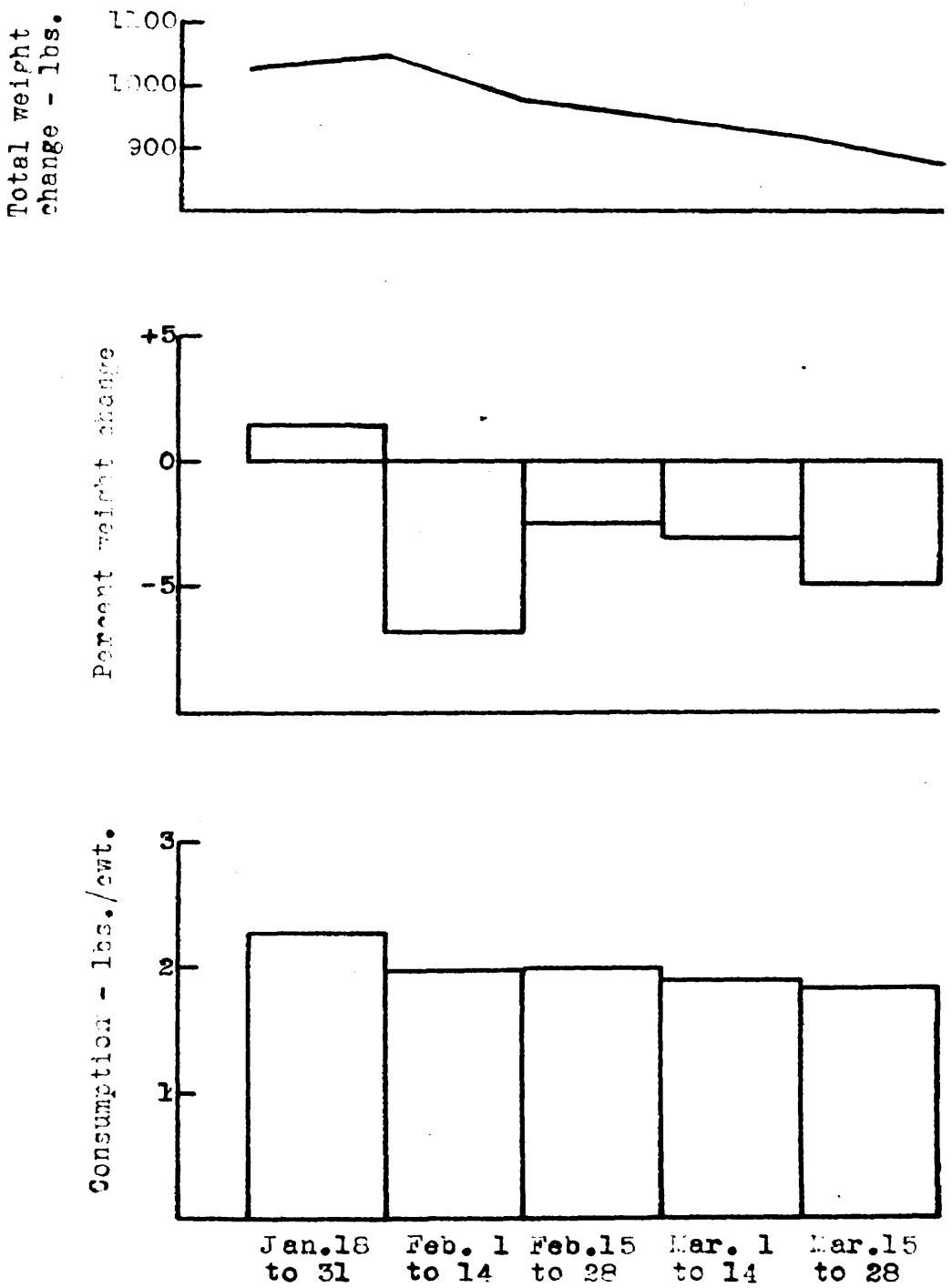


Figure 18.- 1957 forage consumption and weight response by two week periods of four calves fed a diet of 50 percent bunchgrass plus deciduous browse plus conifers.

RESULTS WITH 50 PERCENT BUNCHGRASS PLUS DECIDUOUS BROWSE PLUS LODGEPOLE PINE

Two calves were fed this type of diet in order that some utilization of lodgepole pine would be achieved. It was hoped that if only one species of conifer was available the calves would consume enough lodgepole pine to reflect its importance as a constituent of the calves' diet. Use of pine was not achieved to any degree as was the case in other diets comprising conifer browse. Figure 19 shows that the calves did consume significant amounts for a period of approximately two weeks, but thereafter ate only small amounts very irregularly.

Lodgepole pine made up only 4 percent of the calves' diet throughout the 70 day period with most of the consumption of pine occurring during the first month. Figure 20 shows that these calves reacted to the diet differently than other calves on similar diets. Consumption was high the first two weeks with an increase in body weight, but thereafter the weight declined at a fairly uniform rate even though consumption increased the last month of the study. Bunchgrass consumption remained quite stable throughout the study with fluctuations occurring toward termination.

The two calves on this diet ate an average of 2.03 pounds per hundredweight per day and lost 13.05 percent of their initial body weight during the winter of 1957. This

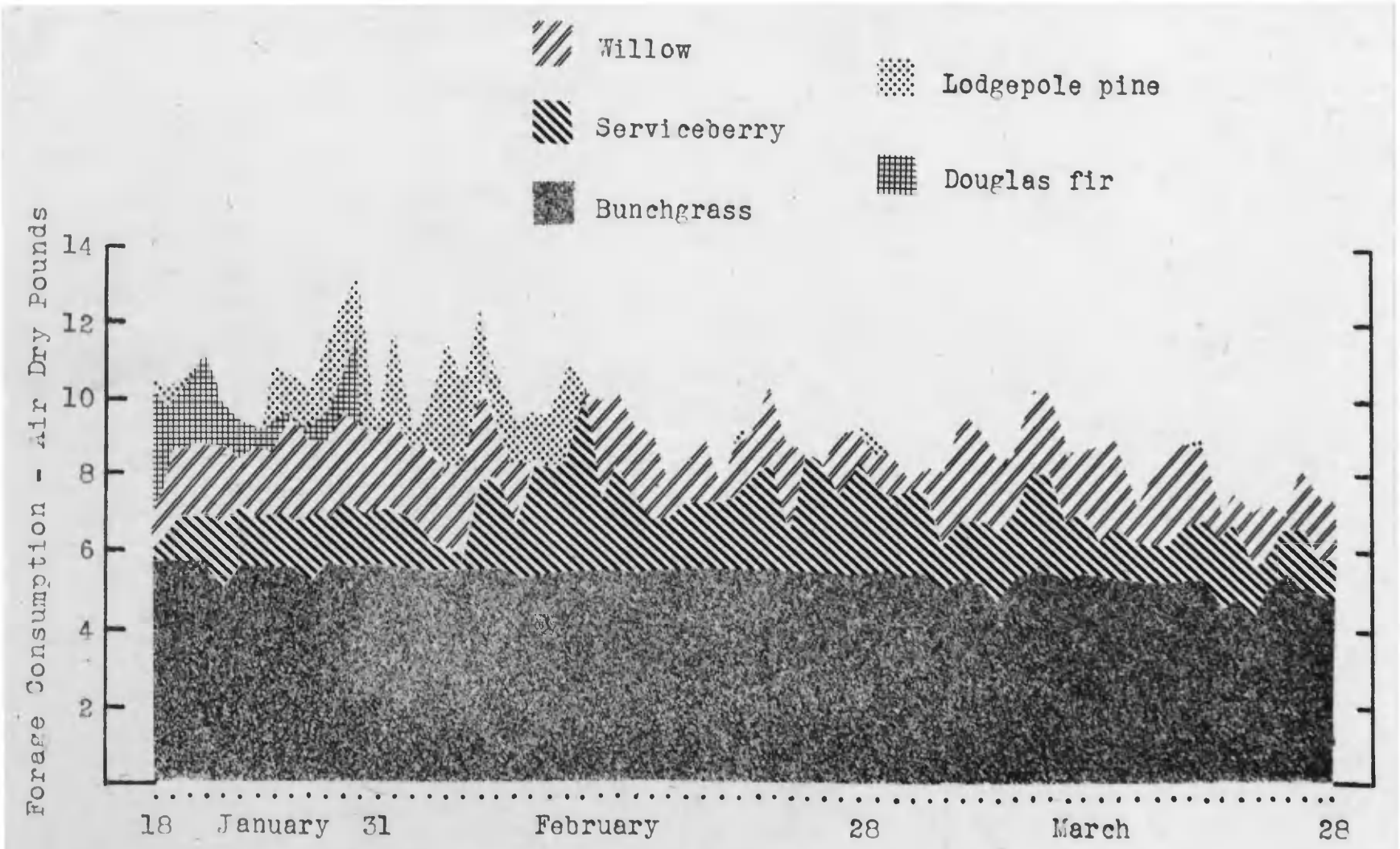


Figure 19.- 1957 daily forage consumption for a pair of elk calves fed a diet of 50 percent bunchgrass plus deciduous browse plus lodgepole pine.

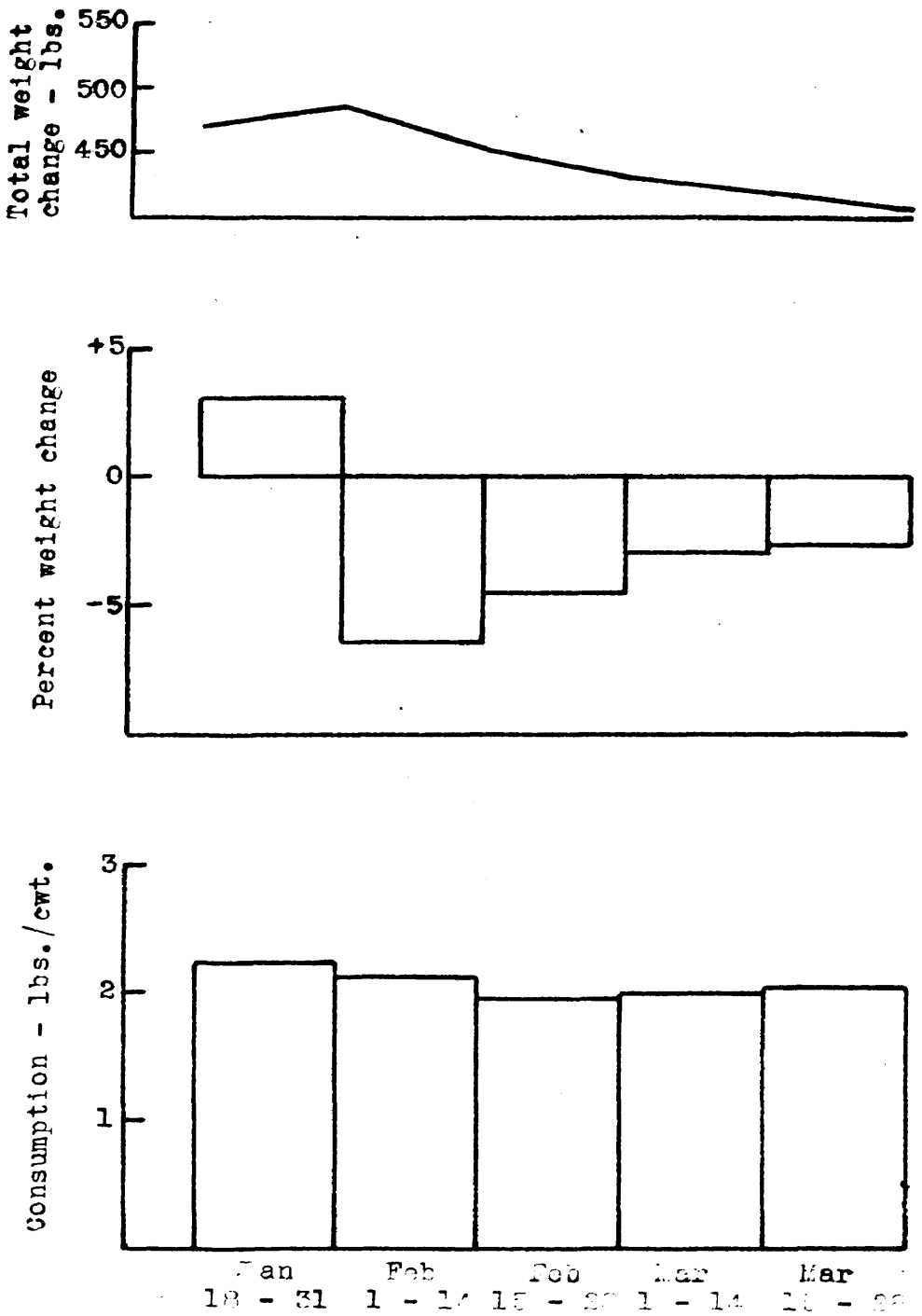


Figure 20.- 1957 forage consumption and weight response by two week periods of two calves fed a diet of 50 percent bunchgrass plus deciduous browse plus lodgepole pine.

particular diet was one of the three diets not repeated during the study the second year.

RESULTS WITH 50 PERCENT BUNCHGRASS PLUS DECIDUOUS BROWSE PLUS DOUGLAS FIR

Two calves formerly on a diet of 50 percent bunchgrass plus deciduous browse plus both species of conifer browse were switched to a diet consisting of bunchgrass, deciduous browse, and only one species of conifer. In this case Douglas fir was the conifer species being offered. The calves ate an average of 1.89 pounds per hundredweight per day throughout the study, including the first two weeks when they were offered both conifers; however, lodgepole pine was not consumed in any appreciable amount during the first two weeks so the diet was essentially one consisting of Douglas fir. See Figure 21. The calves lost an average of 13.3 percent of their initial body weight during the 70 days. Weight loss by two-week period was fairly uniform. Figure 22 shows the relationship between consumption and weight response.

This diet was not repeated during the 1958 study.

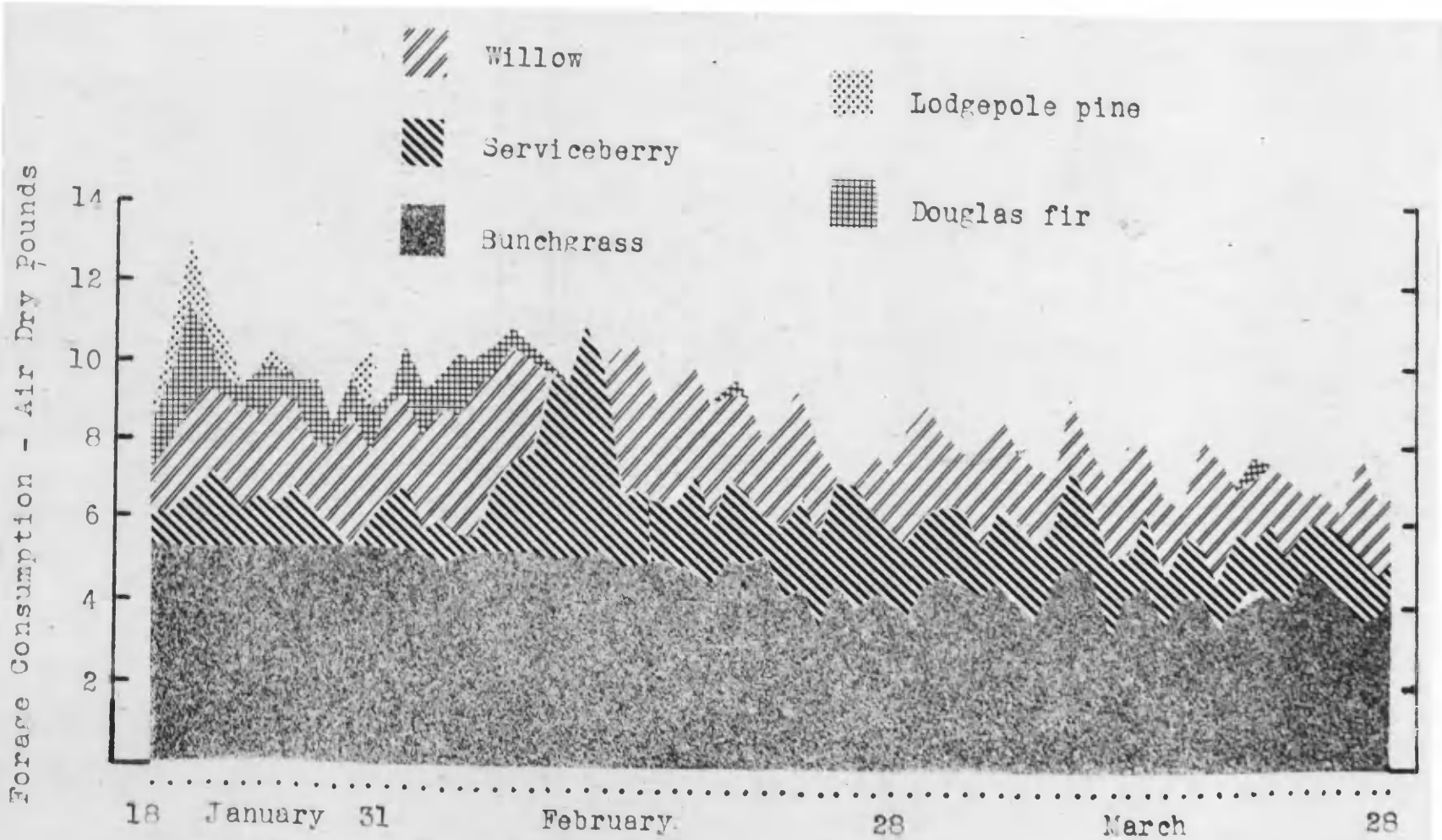


Figure 21.- 1957 daily forage consumption of a pair of elk calves fed a diet of 50 percent bunchgrass plus deciduous browse plus Douglas fir

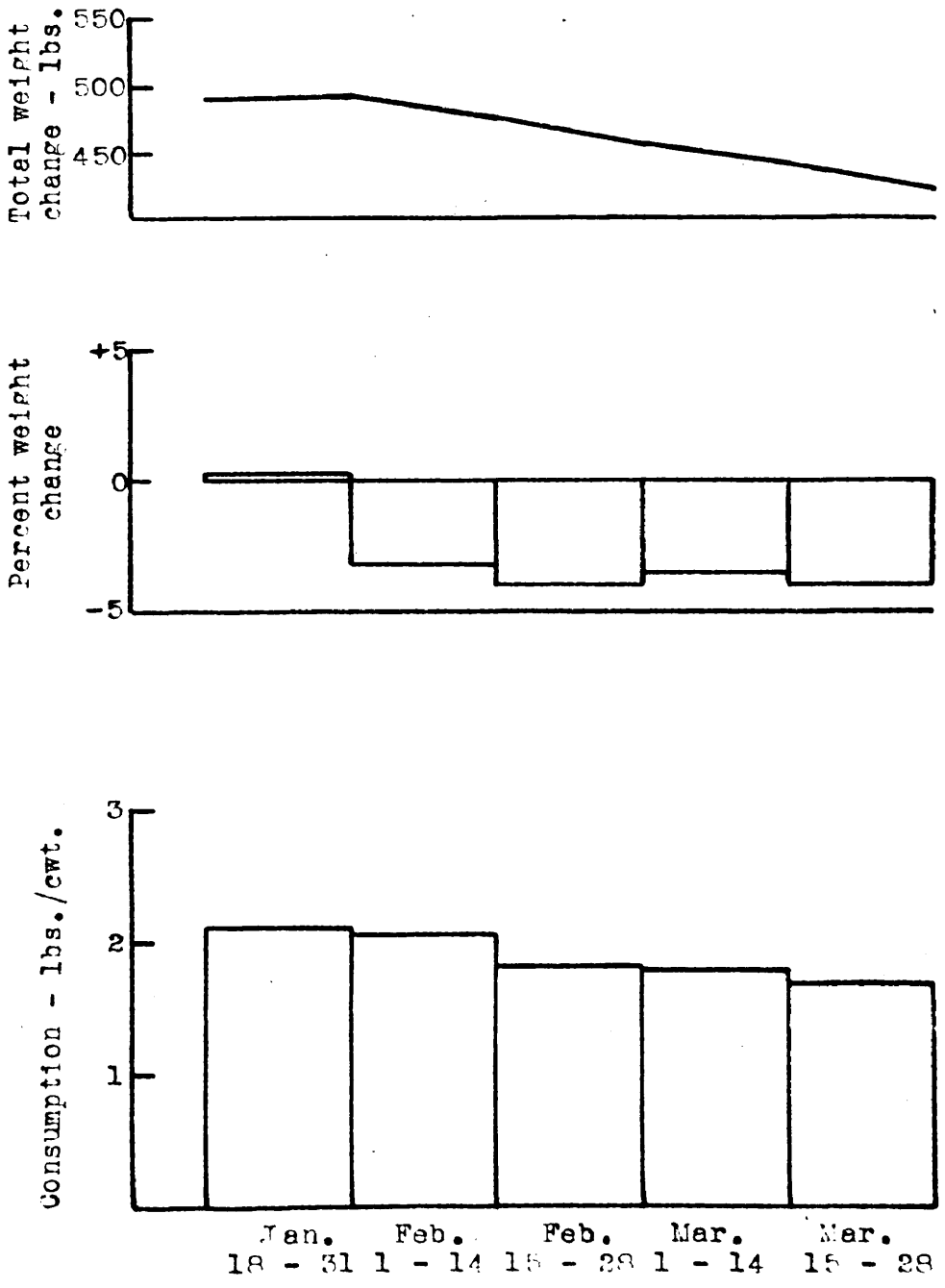


Figure 22.- 1957 forage consumption and weight response by two week periods of a pair of calves fed a diet of 50 percent bunchgrass plus deciduous browse plus Douglas fir.

TABLE 1

Summary of feed intake and weight data for 23 elk calves fed various diets during winter of 1957

DIET	Pen No.	Animal No.	Sex	Initial Wt.	Final Wt.	Gain or Loss Pounds	Gain or Loss Percent	Ave. feed intake per day in lbs. Per cwt.	Ave. feed intake per day in lbs. Per Pen
100% Bunchgrass	1.	3	F	246	209.5	-36.5	-14.8	1.54	12.15
		11	F	227.5	200	-27.5	-12.1		
		22	F	243	199	-44.0	-18.1		
50% Bunchgrass plus Conifers	2.	1	M	190.5	155.5	-35.0	-18.4	1.34	4.91
		9	F	202.5	166	-36.5	-18.0		
	9.	17	M	236.5	214	-22.5	- 9.5	1.53	7.17
		19	M	240	214	-26.0	-10.8		
50% Bunchgrass plus Deciduous Browse	4.	2	F	238.5	217.5	-21.0	- 8.8	1.91	8.84
		7	M	236	207.5	-28.5	-12.1		
	8.	15	F	203.5	180.5	-23.0	-11.3	2.11	8.13
		18	M	198.5	171	-27.5	-13.9		
50% Bunchgrass plus Deciduous Browse plus Conifer	3. Lodge-Pole Pine	10	M	230	200.5	-29.5	-12.8	2.03	9.19
		12	M	240	208	-32.0	-13.3		
	5. Douglas Fir	8	F	244	206	-38.0	-15.6	1.89	8.86
		6	M	246	216.5	-29.5	-12.0		
	6.	4	M	281	234	-47.0	-16.7	1.96	10.42
		13	M	275.5	234	-41.5	-15.1		
	7.	14	M	238.5	201	-37.5	-15.7	1.98	8.89
		16	M	228.5	205	-23.5	-10.3		
100% Meadow Hay	10.	20	F	214	221	- 7.0	- 3.3	2.57	24.66
		23	F	271.5	261	-10.5	- 3.9		
		24	F	249.5	229	-20.5	- 8.2		
		25	F	242.5	228	-14.5	- 6.0		

TABLE 2

Summary of feed intake and weight data for 10 elk calves fed various diets during winter of 1958

		Animal No.	Sex	Initial Wt.	Final Wt.	Gain or Loss Pounds	Gain or Loss Percent	Ave. Feed Intake Per cwt.	Ave. Feed Intake Per Pen
100% Meadow Hay	1.	1	M	256	263	+ 7	+2.73	2.29	11.71
		5	F	251.5	249.5	- 2	- .80		
	5.	9	F	224.0	218.5	-5.5	-2.46	2.03	4.47
	6.	10	F	242	242.5	-0.5	- .21	2.11	5.10
100% Bunchgrass	2.[1]	2	M	254	220	-34	-13.19	1.43	6.36
		4	M	216	200	-16	- 7.4		
	2.	4	M	200	178.5	-21.5	-10.7	1.35	2.55
	7.	2	M	220	220.5	-0.5	- .23	1.94	4.26
50% Bunchgrass plus deciduous browse	4.	6	M	280	262.5	-17.5	-6.25	2.06	11.23
		8	M	284.5	264.5	-20.0	-7.03		
50% Bunchgrass plus conifer browse	3.	3	M	232	206	-26	-11.21	1.72	7.52
		7	F	232.5	210.5	-22	- 9.46		

[1]Figures for two weeks only - animals separated and fed single the remainder of the study.

ANALYSIS OF RESULTS

A representative sample of the forage consumption data was analyzed statistically to provide a basis for rating the particular diets in importance as maintenance rations for wintering calf elk. The sample represents consumption data for the 14 day period midway between the commencement and the termination of the 1957 study. See Table 3. It was desired to use this period because the elk were supposedly well accustomed to their environment and also because this period contained a few cold days.

The analysis shows that some diets are significantly different from others in their effect on forage consumption. The significance is attributed to the particular diets and not to the effect of daily variations in consumption as it might be affected by temperature, wind, snow, or other inherent variables.

The meadow hay diet was the best diet fed during the study. In comparison, the other diets would have to be ranked as follows, from best to poorest:

1. 50 percent bunchgrass plus deciduous browse
2. 50 percent bunchgrass plus deciduous browse plus lodgepole pine
3. 50 percent bunchgrass plus deciduous browse plus conifer browse
4. 50 percent bunchgrass plus deciduous browse plus Douglas fir
5. 100 percent bunchgrass
6. 50 percent bunchgrass plus conifer browse

These conclusions parallel those of many investigators who contend that the best elk winter range consists of an ample supply of grass plus nutritions and palatable browse.

TABLE 3

Consumption Data Used in Statistical Analysis
For 14 Day Period From Feb. 15 to Feb. 28, 1957

	Diet A	Diet B	Diet C	Diet D	Diet E	Diet F	Diet G
Daily Consumption/cwt.	2.50	1.71	2.29	1.36	2.10	1.93	1.89
	2.62	1.74	2.18	1.40	2.06	2.08	2.19
	2.48	2.05	2.15	1.55	1.79	2.19	2.01
	2.72	1.40	2.39	1.36	1.88	1.91	2.20
	2.46	1.74	1.99	1.44	2.08	2.04	2.15
	2.79	1.49	2.03	1.43	2.76	1.97	2.14
	2.89	1.89	2.09	1.27	2.04	1.74	1.82
	3.32	1.76	2.00	1.24	2.04	1.85	2.04
	2.98	1.92	2.34	1.33	2.35	2.02	2.04
	2.69	1.88	2.18	1.18	1.95	1.70	2.06
	2.22	1.52	1.65	1.10	1.97	1.52	1.69
	2.25	1.31	1.74	.96	1.90	1.50	1.95
	2.85	1.18	1.71	.95	2.06	1.67	1.85
	2.83	1.46	2.10	1.36	2.10	1.57	1.95
Mean	2.69	1.65	2.06	1.28	2.01	1.84	2.00

Least Significant Difference at 5% = .189

Least Significant Difference at 1% = .264

Diet A = 100% Meadow Hay
Diet B = 100% Bunchgrass
Diet C = 50% Bunchgrass plus Deciduous Browse
Diet D = 50% Bunchgrass plus Conifer Browse
Diet E = 50% Bunchgrass plus Deciduous Browse plus Lodgepole Pine
Diet F = 50% Bunchgrass plus Deciduous Browse plus Douglas Fir
Diet G = 50% Bunchgrass plus Deciduous Browse plus Conifer Browse

FORAGE PREFERENCES

Meadow hay was the most preferred forage available to the elk during both years of the study. However, bunchgrass in the absence of hay, was the most preferred of the native forages. The bunchgrass appeared to lose its "flavor" as the study progressed. On diets comprised of limited amounts of bunchgrass, the elk ate the entire ration during the early stages of the study, but later would leave varied amounts and turn to other foods.

Snowbrush, willow, and serviceberry were the three deciduous species offered to the elk the first year of the study. Snowbrush—(*Ceanothus velutinus*)--shall be considered deciduous as it is quite unlike the conifer species used during the study. During the free choice adjustment period snowbrush was the most preferred of this class of forage, making up 56 percent of the total deciduous consumption and 12 percent of all feeds taken. Willow made up 33 percent and serviceberry 11 percent of the deciduous class. See Table 4 for preference ratings based on availability and total daily consumption.

During the 1957 study period, snowbrush was not offered to the elk in any of the diets due to lack of supply. Table 5 shows preference ratings for browse species based on percent of average total daily consumption for both classes

of browse. Willow was the more preferred during the 70 day period but not by as great a margin as during the free choice period. Of the diets incorporating the feeding of both deciduous species, willow made up 21.5 percent of the diets and serviceberry made up 20.4 percent. See Table 7 for a detailed tabulation of this information.

During the 1958 study period a more pronounced difference in preference occurred between the two deciduous species; however, it was exactly opposite from the previous year. See Table 6. Table 7 shows that the diet consisting of 50 percent bunchgrass and deciduous browse was made up of 27 percent serviceberry and 17 percent willow. Since only one trial was conducted the second year of the study on this particular diet one cannot conclude that serviceberry is the more preferred forage unless temperature has an effect on preference. The second year was considerably warmer than the first.

It was noted during the study that willow appeared to be heavily utilized in comparison to serviceberry. In some instances the elk chewed down to four and five year old wood, but this occurred very irregularly and only when not enough browse was available (Plate V).

Willow and serviceberry were measured to determine the percentage of each that constituted palatable forage material. Current and two year old growth were considered to be

acceptable forage. It was found that serviceberry, on a weight basis, produces more palatable forage, having 24.04 percent of the total branch weight composed of current and two year old growth. Willow produces slightly less forage with 19.71 percent of the branches of current and two year old growth. All branches were cut approximately three and one-half feet in length.

Lodgepole pine was the more preferred conifer during both years of the study except during the free choice adjustment period the first year. During this period Douglas fir was the most preferred of all classes of browse. See Table 4. However, lodgepole pine assumed the more preferred status during the study periods. Tables 5, 6, and 7 give detailed tabulation of results.

During the study periods instances of extreme preference were evident (Plate V). The calves seemed to prefer lodgepole pine from older trees bearing cones rather than the young seedlings; however, a few instances of extreme seedling use occurred. Some instances of preference also occurred on Douglas fir, but no definite pattern prevailed. The calves did prefer Douglas fir from the Tote Road area over that which was secured on Evaro Hill, however.

TABLE 4

1957 Forage Preference Based on Percent of Available Forage Eaten Per Day and Percent of Total Daily Consumption During Preliminary Free Choice Adjustment Period

	Total Lbs. Avail.	Percent Avail-ability	Ave. Lbs. Avail. Per Day	Total Lbs. Eaten	Ave. Lbs. Eaten Per Day	Percent of Avail. Eaten	Percent of Total Daily Consumption	No. of Pen Days Avail.
Hay	564.5	9.34	8.43	382.6	5.71	68	43	67
Amelanchier	1135.3	18.78	21.02	16.0	.30	1.4	2	54
Salix	1047.9	17.33	19.40	50.0	.93	4.8	7	54
Douglas fir	935.1	15.47	17.32	88.6	1.64	9.5	12	54
Lodgepole pine	722.6	11.95	13.38	31.7	.59	4.4	4	54
Bunchgrass	990.0	16.38	14.35	177.1	2.57	17.9	19	69
Ceanothus	649.2	10.74	17.08	59.5	1.57	9.2	12	38
	6044.5	100.00			13.31			

TABLE 5

1957 Browse Preference Based on Percent of Available Forage Eaten Per Day and Percent of Total Daily Consumption During Study Period

	Total Lbs. Avail.	Percent Avail-ability	Ave.Lbs. Avail. Per Day	Total Lbs. Eaten	Ave.Lbs. Eaten Per Day	Percent of Avail. Eaten	Percent of Total Daily Consumption	No. of Pen Days Avail-able
Amelanchier	12,112.7	35.35	173.04	1281.0	18.30	10.6	37	70
Salix	10,291.8	30.04	160.81	1431.3	22.36	13.9	45	64
Douglas fir	6,509.2	19.00	92.99	291.1	4.16	4.5	8	70
Lodgepole pine	5,345.5	15.60	76.34	322.5	4.61	6.0	9	70
	34,259.2	99.99			49.43			

TABLE 6

1958 Browse Preference Based on Percent of Available Forage Eaten Per Day and Percent of Total Daily Consumption During Study Period

	Total Lbs. Avail.	Percent Avail-ability	Ave.Lbs. Avail. Per Day	Total Lbs. Eaten	Ave.Lbs. Eaten Per Day	Percent of Avail. Eaten	Percent of Total Daily Consumption	No. of Pen Days Avail-able
Amelanchier	1131.5	32.26	32.33	147.4	4.21	13.0	39.9	35
Salix	1093.2	31.17	31.23	97.1	2.77	8.9	26.2	35
Douglas fir	553.2	15.77	15.81	46.6	1.33	8.4	12.6	35
Lodgepole pine	729.3	20.79	20.84	78.3	2.24	10.7	21.2	35
	3507.2	99.99			10.55			

TABLE 7

1957 and 1958 Browse Preference Based on Percent Composition of Diets During Study Periods

Diet		Bunchgrass	Salix	Amelanchier	Douglas fir	Lodgepole pine
50% Bunchgrass plus deciduous browse	1957	50.5%	23.5%	26%		
	1958	56%	17%	27%		
50% Bunchgrass plus conifer browse	1957	80%			7.5%	12.5%
	1958	69%			11.5%	19.5%
50% Bunchgrass plus deciduous browse plus conifer browse		54%	21.5%	17.5%	4%	3%
50% Bunchgrass plus deciduous browse plus Lodgepole pine		54%	23%	19%		4%
50% Bunchgrass plus deciduous browse plus Douglas fir		59%	18%	19%	4%	

DIGESTIBILITY OF THE FEEDS

Although chemical analysis of forage does not always give a true index to the nutritive value of a food, it does provide a basis of comparison between foods on the relative proportions of nutritional constituents contained in each forage species.

Calculated digestibilities were used in an attempt to further rate the diets as to their relative importance as a winter maintenance ration for elk calves. The apparent digestibility of the feeds was calculated by means of the lignin ratio method. However, calculated digestibilities were considerably lower than values obtained in previous studies. This would indicate that the method employed is of questionable validity or else gross errors were made in chemical analysis. From information secured from other sources it seems highly probable that errors were made in analysis or the inherent errors peculiar to the method of analysis were accentuated. The diet of 100 percent meadow hay has a calculated digestibility of only 35.34 percent. This figure is approximately 20 percent lower than data obtained during previous years and from the literature.

Smith, et. al. (1956) questioned the appropriateness of the lignin ratio technique because of the difficulty of consistent quantitative lignin analysis. He had eight

separate analyses made of each class of feed and found that variations in lignin values for the same sample was considerable, a 172 percent difference in one instance. He concluded that greatly different digestion coefficients are possible, depending upon which of the sets of values might have been received from the laboratory.

Smith, in the same article, stated that some investigators hold this method highly valid while other investigators have no faith in the results.

Table 8 exhibits an attempt to correlate calculated digestibilities with results of the study; however, no apparent correlation exists. The significant elements of the data are in order of feed intake as affected by the particular diet.

Digestibilities for diets fed during the second year of the study were not calculated from chemical analysis because of the unreliable results obtained the first year.

TABLE 8

1957 -- Calculated Digestibilities in Relation to the Results of the Study

Diet	Forage Consumption Per Hundredweight	Percent Lignin in Feed	Percent Lignin in Feces	Calculated Apparent Digestibility	Weight Loss
100% Meadow Hay	2.57	14.9	21.3	35.34	3.7
50% Bunchgrass plus deciduous browse	2.11	22.1	31.7	38.87	12.6
50% Bunchgrass plus deciduous browse plus lodgepole pine	2.03	24.1	33.3	36.36	13.0
50% Bunchgrass plus deciduous browse plus conifers	1.98	25.2	31.8	27.77	13.0
50% Bunchgrass plus deciduous browse plus conifers	1.96	24.5	32.1	31.41	15.9
50% Bunchgrass plus deciduous browse	1.91	24.0	32.2	33.55	10.5
50% Bunchgrass plus deciduous browse plus Douglas fir	1.89	24.6	32.1	30.37	13.8
100% Bunchgrass	1.54	20.1	27.0	32.00	15.0
50% Bunchgrass plus conifers	1.53	22.6	29.9	31.51	10.1
50% Bunchgrass plus conifers	1.34	21.9	31.5	39.05	18.2

PALATABILITY AND NUTRITIVE VALUE OF THE FEEDS

Palatability, as described by the United States Department of Agriculture (1935) is, "the degree to which the herbage within easy reach of the stock is grazed when the range is properly utilized under the best practical range management." Palatability ratings, when used in conjuction with optimum range management, are an index of preference. The range, to be best managed, has to be managed for continuation of the plants receiving the highest use in a given season. These highly used plants are therefore the most preferred.

Swift (1948) made the statement that deer, entirely free to choose, ate those feeds which gave them more nutrients. This happened to be a case where the deer chose the nutritionally higher plants of a single forage class and not between classes such as the elk were offered.

Atwood (1948) makes the statement that "there is no correlation between highly palatable foods and highly nutritious ones." Oelberg (1956) also states that chemical analysis data has to be interpreted with great care as many plants found to be highly nutritious by chemical analysis proved to be worthless as animal forage because they lacked palatability.

The nutritive values of the forages fed during the winter of 1957 are shown in Table 9. It would appear from chemical analysis alone that the coniferous species are highly nutritious feeds. However, they are of insignificant importance as an elk food due to their low palatability. The turpene content of coniferous species is the probable limiting factor of palatability.

By range management standards, those feeds which receive the heaviest use are the most palatable; therefore, preference and palatability of feeds used during this study are identical.

TABLE 9

Chemical Analysis of Forage Species Fed During the 1957 Elk Nutrition Study.

Tests Conducted by the State

Agricultural Experiment Station, Bozeman, Montana

SAMPLE	MOISTURE	PROTEIN	N.F.E. EXT.	ASH	CRUDE FIBER	PHOS.	LIGNIN
Bark	5.0	2.8	10.1	3.0	31.4	.04	26.3
Meadow Hay	6.5	5.7	2.2	6.9	29.9	.09	14.9
Bunchgrass	6.4	3.2	4.1	7.5	23.6	.05	20.1
Willow	7.0	6.1	10.4	3.7	33.8	.14	35.8
Serviceberry	6.5	5.2	3.5	2.7	26.4	.11	24.3
Lodgepole Pine	6.0	6.6	8.3	2.1	24.5	.11	30.9
Douglas Fir	5.2	6.1	8.5	3.6	16.1	.13	30.9

EFFECTS OF WEATHER

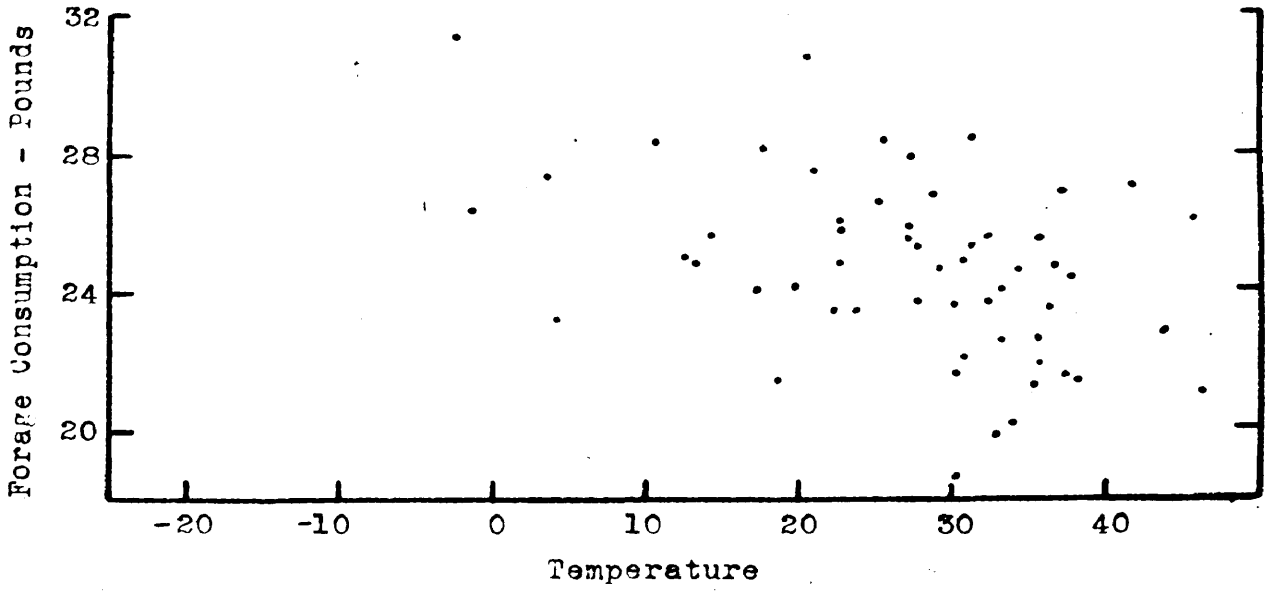
TEMPERATURE

Ragsdale, et. al. (1950) states that a sudden drop in feed consumption was noted with increasing temperatures from 8° to 50° F. They concluded, "feed consumption is associated with extra heat production; therefore, decreasing temperature should increase feed consumption so as to help keep the animal warm, and vice-versa, which is precisely what happens."

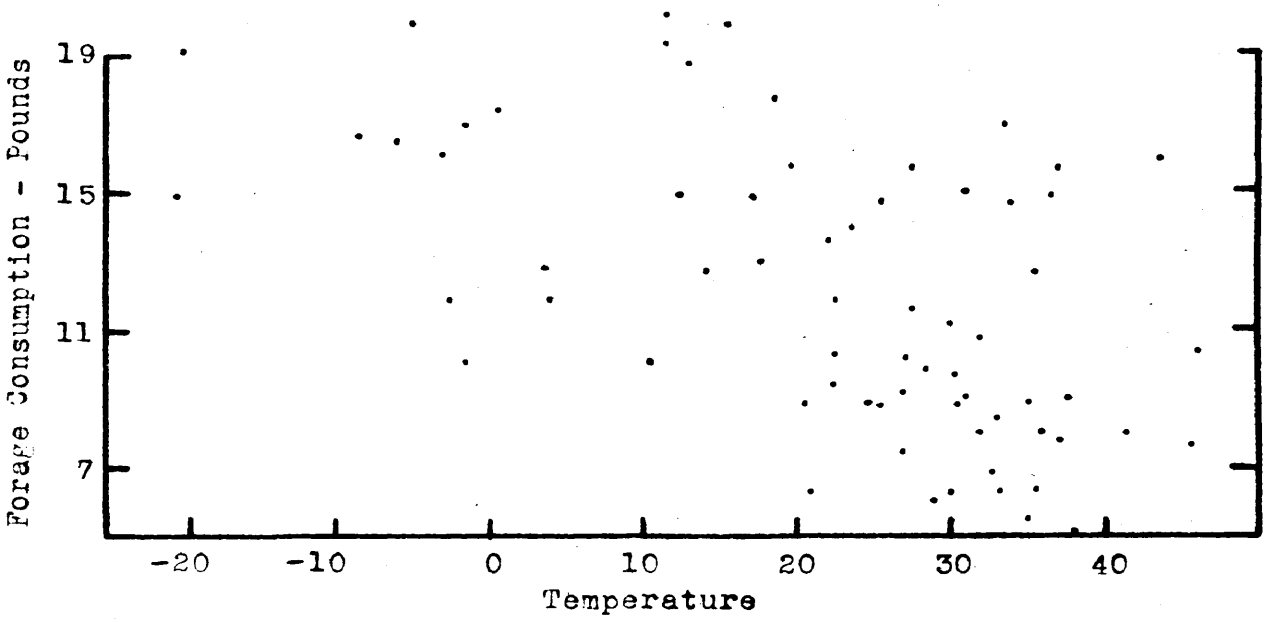
An attempt to correlate temperatures and forage consumption is shown in Figures 23, 24, and 25. From these figures it can be seen that overall temperature changes had no pronounced effect on the consumption, but as temperature rose above freezing the consumption tended to decrease. The relationship appears more definite in instances of nutritionally poor diets and in diets composed of a single forage species.

It was unfortunate that the coldest period during the 1957 study period occurred during the first two weeks. The high forage consumption during this period cannot definitely be correlated with the low temperatures alone because of the possibility that the penned animals had not yet become accustomed to their environment.

An attempt was made to study this problem the second

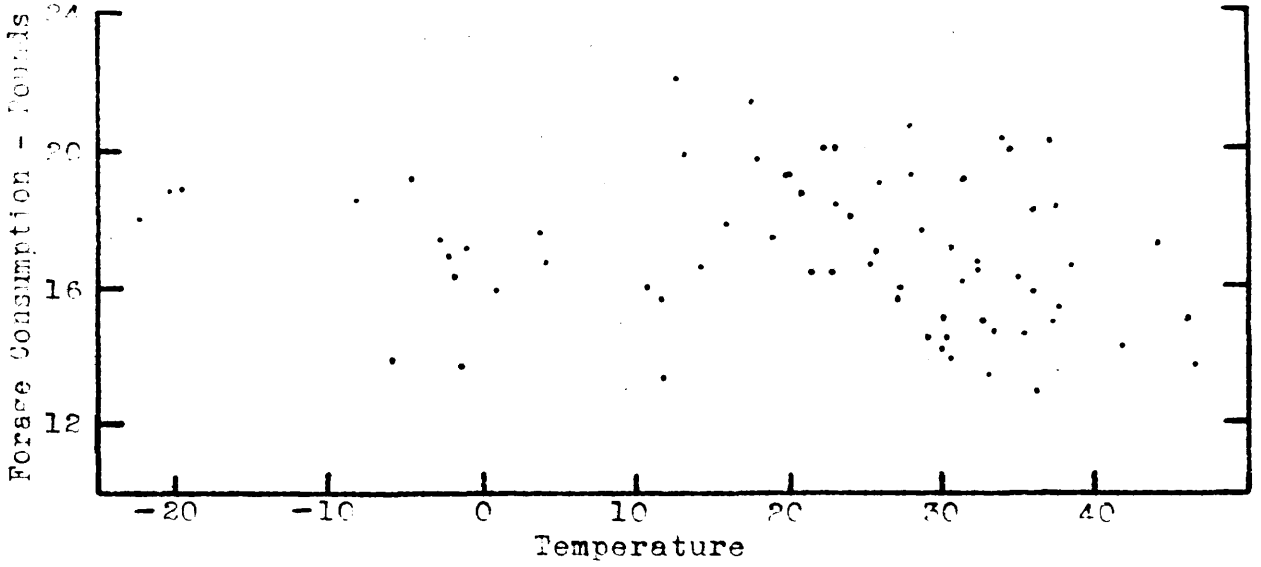


Diet of 100 percent meadow hay

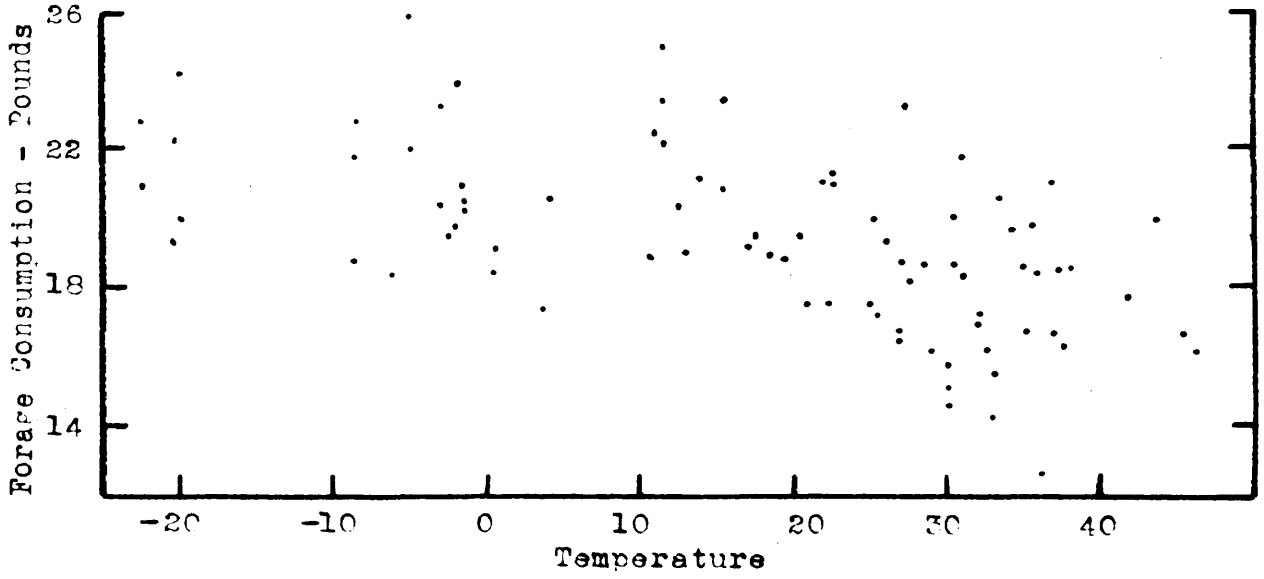


Diet of 100 percent bunchgrass

Figure 23.- 1957 relationship between forage consumption and temperature.

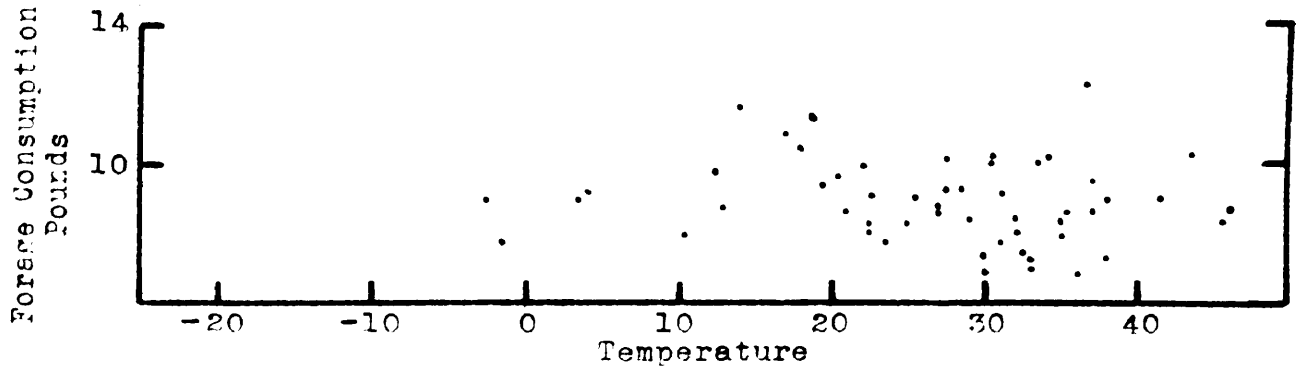


Diet of 50 percent bunchgrass plus deciduous browse.

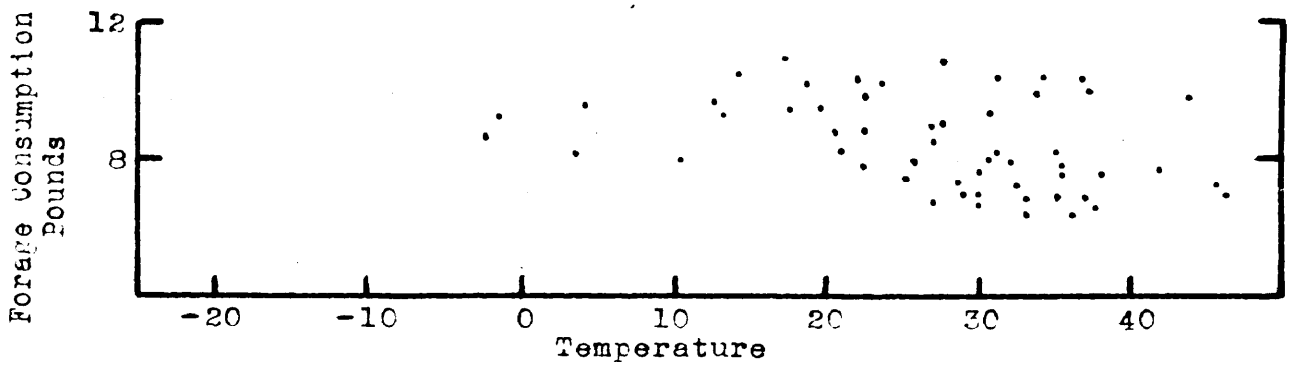


Diet of 50 percent bunchgrass plus deciduous browse plus conifers.

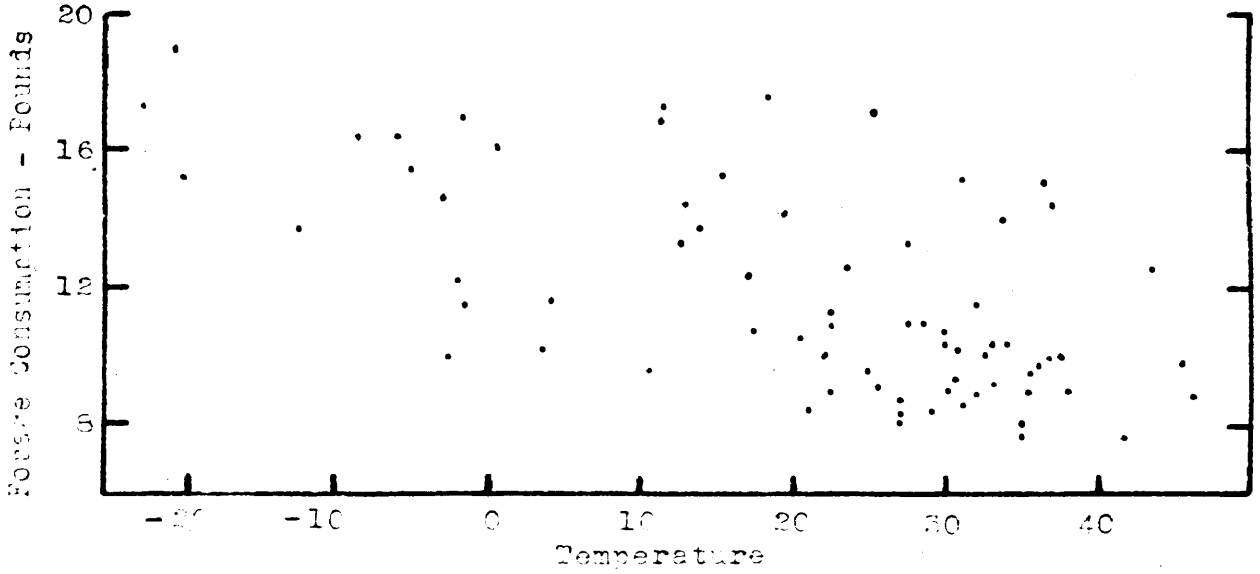
Figure 24.- 1957 relationship between forage consumption and temperature.



Diet of 50 percent bunchgrass plus deciduous browse plus lodgepole pine



Diet of 50 percent bunchgrass plus deciduous browse plus Douglas fir.



Diet of 50 percent bunchgrass plus conifer browse.

Figure [illegible].- 1959 relationship between forage consumption and temperature.

year, but no relationship was found to exist between consumption and temperature, perhaps because of the abnormally mild winter. Graphic representation of 1958 data is therefore not included in the text.

WIND

A graphic analysis was attempted to measure the effects of wind on feed intake, but the relationship normally expected, namely that of high wind velocity, increase of heat loss, and an increase in forage consumption was not found. See Figures 26 and 27 for graphic representation of temperatures and wind velocities.

SNOW

Snowfall had no effect on consumption. The elk did not seem to mind getting wet, especially while they were eating. The only noticeable effect of a fresh snowfall was the decrease in consumption of water supplied. The elk preferred to eat the new snow.

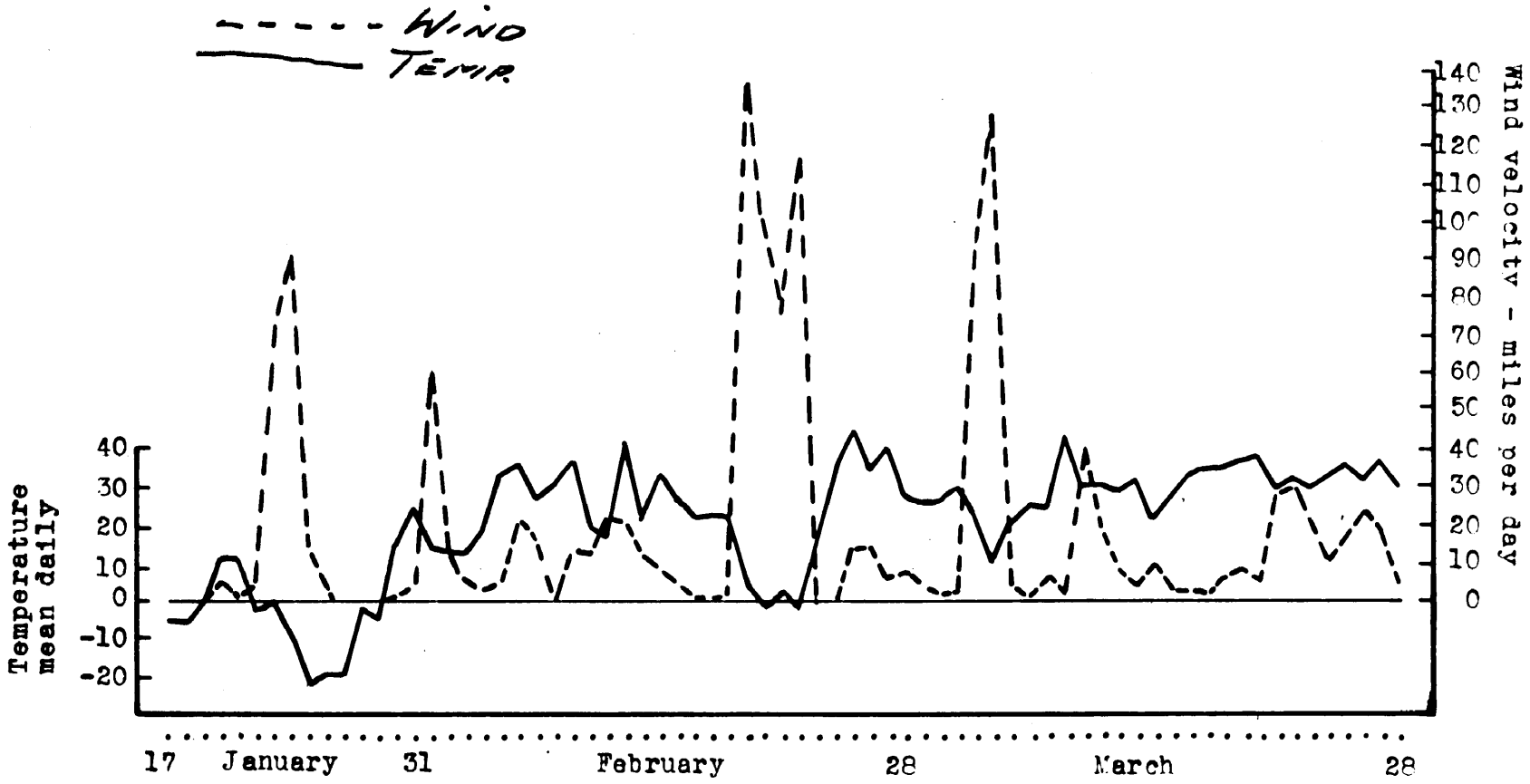


Figure 26.- 1957 mean daily temperature and wind velocity variation.

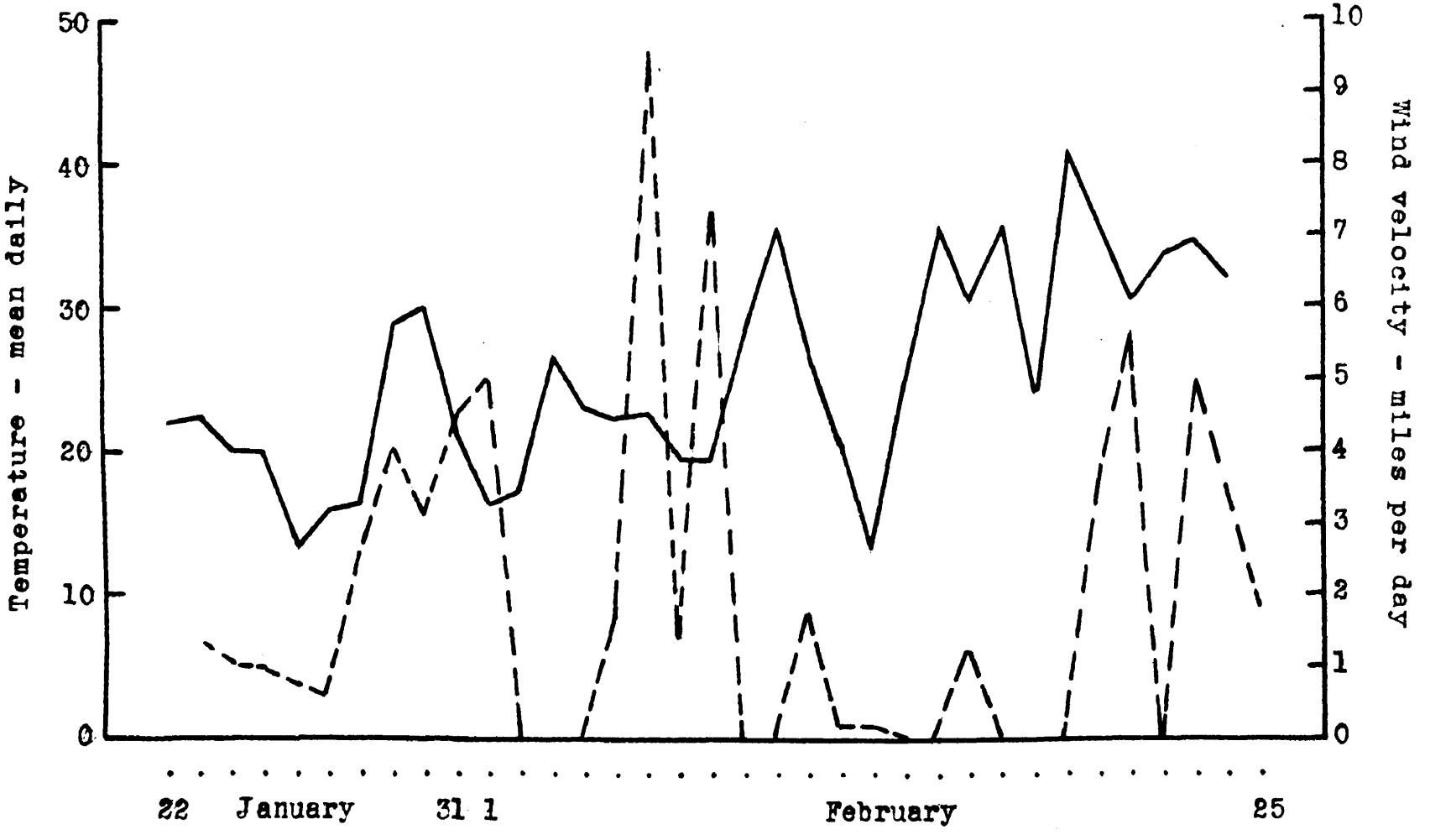


Figure 27.- 1958 mean daily temperature and wind velocity variation.

ADDITIONAL OBSERVATIONS

WATER AND SALT CONSUMPTION

Water was made available to all the calves throughout the study periods. However, the water consumption was quite variable among the elk. Some would drink while others would completely ignore the water. It was quite definite that some diets induced a greater water consumption than others. The calves fed a 100 percent diet of hay or bunchgrass frequently drank all the water that was available and also were more regular in the use of water. This was probably due to the low moisture content of these feeds. The calves on browse and mixed diets apparently required less water as they would seldom drink. Fresh snow had a bearing on water consumption as drinking was at a minimum after a fresh snowfall and muzzle-marks could be observed in all the pens and calves were seen eating snow.

As previously stated, salt was made available in cans nailed to the feed bunks. No records were kept of amounts of salt used. The use of salt was very irregular. When it was first made available, almost all the elk used the salt to a large degree, but as the study progressed very small amounts were used and no particular diets induced higher salt consumption. The initial heavy use would suggest that

the salt was a novelty and not a necessity during the winter months.

CONSUMPTION OF CONCENTRATES

Protein pellets were purchased prior to the study to feed to the elk in the event their general condition reached a low level. After all, the study was designed to measure effects of diets on elk and not to produce data on how long they survived on low quality diets. During the preliminary period prior to placing the calves on study diets, these protein pellets were offered to all the calves in small amounts, but the majority refused to eat them. The replacement animals held in the holding corral were offered the supplement periodically, but no consumption was evident at any time.

ANIMAL TEMPERAMENT AND BEHAVIOR

The calves were very amiable toward one another throughout the entire study. All were very nervous when first released in the holding corral, but quieted down rapidly and seemed unconcerned about normal human activity in the vicinity. They were, however, very curious and would watch every move made by my assistant and myself. Only one possible instance of dominance was observed during the second winter of the study. One of two elk in a pen would

not eat. When separated, this calf resumed a nearly normal feed consumption.

All calves became very nervous during the course of weighing and much pacing and excitement was evident. However, once the calves were weighed and returned to their pens, they quieted down rapidly and went about their normal activities within a few hours.

During the course of the study, the calves became noticeably more tame. At times they would venture out from behind their canvas draped shelters and watch the personnel place the new day's ration in the feeding apparatus. In some instances they would lie down and watch. As soon as we were out of their immediate vicinity the calves would begin feeding.

The calves were inclined to form habits as was noted whenever their feeding schedule was interrupted. More striking, however, was their habit of becoming accustomed to a certain pen. Whenever they were weighed and released they returned to their pens through the series of turns without hesitation. At the close of the study when the elk were to be released, their individual pen gates were closed to their return. When the elk were released from the weighing stall they dashed to their pen gates and milled about like so many "lost sheep." Most had to be driven out the release gate, none going out on their own initiative.

It was quite humorous to witness the elk whenever they were in a playful mood. They would romp about with no concern for whomever happened to be watching from a fairly close distance. False steps on icy surfaces provided many laughs.

During both years of the study the calves were observed stripping the bark off the rail fences. A sample of bark was sent, along with the forage and fecal material, to Bozeman for chemical analysis. For results of this analysis see Table 9. Whether or not the calves were receiving a deficient vitamin or mineral from this bark is wholly unknown.

Many investigators have described the feeding habits of elk. Schwartz and Mitchell (1945) state that the plant which is most palatable and abundant at the time receives the greatest use. In winter they feed longer and more closely on individual clumps of browse or patches of vegetation. This habit was evident during the study as the elk would frequently feed on one bundle of browse until most of the more palatable material was consumed before moving to another bundle.

DISEASE, INJURY AND MORTALITY

Injury to the calves was never serious in any instance. Bruised noses occurred at times when the elk were weighed, but this type of injury has to be expected when dealing with a wild animal.

Only one calf died during the two years. The ultimate cause of death was definitely starvation, but investigation revealed that this calf was injured during trapping operations and therefore death was not attributable to the feeding program.

SUMMARY

A study dealing with elk calf nutrition was conducted during the winters of 1957 and 1958 at the Blackfoot-Clearwater Elk Game Range experimental site. Objectives of the study were to determine the forage requirements, measure the effects of different diets on growth and survival, determine the forage preference for various forage species, and evaluate meadow hay with native forages as a maintenance part of the elk calves.

Experimental animals were obtained principally from the Game Range population with the exception that eight calves were sent from Yellowstone Park to the study area the first year. However, only one of these was used as an experimental animal. Twenty-three calves were used in 1957 and in the following year.

Forages fed during the study consisted of alfalfa hay, bunchgrass cut each fall from the Blanchard Flats area of the game range, and meadow hay harvested from the native meadows during each summer. The deciduous browse species were collected weekly from the Evaro Hill area by hand labor and conifers were cut by the investigator from the Toto Road area of the game range.

Preceding the actual 168 day study period all calves were subjected to a "breaking in" adjustment period of 56

nature of a free choice of all diet species for an eight day period. The second year of the study the calves were moved from a preliminary diet of meadow hay directly to their study diets. This was done to measure the effects of an abrupt change in diet.

The diets fed during both years of the study were as follows: 100 percent meadow hay; 100 percent bunchgrass; 50 percent bunchgrass plus deciduous browse; 50 percent bunchgrass plus conifer browse; 50 percent bunchgrass plus deciduous browse plus conifer browse. The last diet was altered wherein two pens were provided with either Douglas fir or lodgepole pine but not both. The 100 percent rations were fed well in excess of animal needs so that maximum consumption would be attained. The limited bunchgrass fraction of the remaining diets was based on 2.5 pounds per hundredweight as determined during previous studies.

The diets consisting of all classes of forage were deleted from the 1958 study due to poor conifer utilization. The 100 percent diets were also altered to provide data for isolated, single animals.

Although facilities were limited, replication of diets was attempted. The calves were fed as pairs with two pens of animals on the same diet except for the 100 percent diets which were not repeated by pen, but by the same number of calves as other diets. Replication during the 1958 study

occurred only with the single calves on the 100 percent diets.

All feed was weighed in and out of the pens each day and a daily record of forage consumption was kept. Forages were fed by the methods employed during previous years. A schedule of feeding was carried out whereby the feeding was done at a certain time and in a set sequence. Water and salt were made available to all the calves. Daily records were kept of weather conditions and periodic samples of forage and feces were taken for analysis.

Four calves fed a ration of 100 percent meadow hay the first year ate 2.57 pounds per hundredweight per day and lost 3.7 percent of their body weight. In 1958 two calves fed as a pair ate 2.29 pounds per hundredweight per day and gained .96 percent of their weight. Two calves fed as single animals ate an average of 2.03 pounds and 2.11 pounds and lost 2.46 percent and gained .21 percent of their body weight, respectively.

Four calves were started on a 100 percent bunchgrass diet the first year, but one died after one month of the study. The calves averaged 1.54 pounds per hundredweight with a loss of 15 percent of their initial weight. Consumption for a pair of calves the second year of the study averages 1.43 pounds per hundredweight with a loss of 10.7 percent. However, when these two calves were separated,

one consumed 1.94 pounds per hundredweight for the remainder of the study and gained back .23 percent of its lost weight. The other calf ate 1.35 pounds per hundredweight and lost 17 percent of its weight during the entire period.

Calves fed the 50 percent bunchgrass plus deciduous browse diet the first year consumed an average of 2.01 pounds per hundredweight and lost 11.5 percent of their weight. Comparable results were obtained the second year with two calves. They consumed an average of 2.06 pounds per hundredweight with a loss of 6.64 percent in body weight.

The ration of 50 percent bunchgrass plus deciduous browse plus conifer browse produced an average consumption among four calves of 1.96 pounds per hundredweight per day with a 13.9 percent drop in animal weight. This diet was not repeated the second year of the study. The two pens of this same diet that were altered to instigate some conifer consumption produced results comparable to the unaltered diet. The two calves offered only Douglas fir as the conifer component of the diet ate an average of 1.89 pounds per hundredweight and lost 13.8 percent of their initial body weight. The calves offered only lodgepole pine in the same type of diet consumed 2.03 pounds per hundredweight and lost 13.05 percent of their weight.

The first year of the study, four calves were fed a ration of 50 percent bunchgrass plus conifer browse. These calves consumed an average of 1.43 pounds per hundredweight per day with a total weight loss amounting to 14.2 percent. Only two calves were subjected to this diet the second year, consuming an average of 1.72 pounds per hundredweight per day for 35 days and losing 10.33 percent of their initial body weight.

Three methods for rating the forage on a preference basis were used. One method calculated preference on a percent of total daily consumption; the other two methods based preference on the percent of available forage that was eaten daily and also as percent composition of each particular diet. See Tables 4, 5, 6, and 7 for tabular representation of preference ratings by the three methods. As an illustration of preference ratings based on the percent composition of diets the data shows that during the 1957 study period willow made up 21.5 percent of the diets; serviceberry, 20.4 percent; lodgepole pine, 6.5 percent, and Douglas fir, 5.2 percent. However, 1958 produced different preferences: willow, 17 percent; serviceberry, 27 percent; lodgepole pine, 19.5 percent; and Douglas fir, 11.5 percent.

Weather, as it affected the elk either through consumption variations or animal response, was studied along with the other requirements of the study during both years. The

only generalization that can be made is that as temperatures rise above the freezing point the feed consumption is likely to decline somewhat for diets of low quality or those composed of only one type of forage. However, when diets are of high quality, changes in temperature had no effect on forage consumption. See Figures 23, 24, and 25.

The digestibilities of the various diets were calculated using the lignin index method, but questionable results were obtained for diets fed during the 1957 study and forage and fecal material was not analyzed the second year. In general, the bunchgrass plus deciduous browse diet had the highest digestibility with bunchgrass plus conifers and meadow hay a very close second. The 100 percent bunchgrass diet and the diet consisting of all forage classes were very low in relative digestibility.

Additional observations were recorded for salt and water consumption, animal temperament and behavior, and disease, injury, and mortality.

CONCLUSION

During the winter, stock on native range lose weight as the forage declines in nutritive value. No records of weight loss for elk on native winter range are available at present. Trapping and weighing elk in the wild is quite a job and the possibility of trapping the same animals periodically throughout the winter is highly unlikely. It seems logical that wild elk exhibit a marked drop in weight during the winter, as indiacted by the apparent condition of many animals in the spring.

Winter is the critical period for all big game animals as it is the time when natural feeds are very low in nutritive value and largely unavailable. Browse is the key forage during this period as its availability is less affected by snow depth. Elk, being the most versatile of the wild ruminants in relation to food habits, can survive a severe winter on low nutritive forage provided feed intake is maintained.

Because forage requirements for individual elk vary, a definite consumption level to maintain body weight and conditions during the winter is hard to ascertain. In general, meadow hay consumption in excess of 2.3 pounds per hundredweight will produce slight gains in calf weight during a winter. This figure was determined from data accumulated

during this and past studies. Consumption data for native forages indicates that the calves will normally lose body weight over a long winter period regardless of desired levels of consumption. Although, if the calves maintain a steady rate of consumption, the animal's condition will not decline rapidly to a critical level. Consumption of approximately 2.00 pounds and above per hundredweight per day appears to fulfill the normal requirements of elk calves to survive the winter without reaching a poor condition.

Elk preference for any one species of browse may vary between areas, herds, and even individual animals. However, if use is a valid criterion of preference then the data indicates that it is highly probable that preferences do vary throughout an elk population.

Information obtained from this study indicates that the grassy type of forage was the most preferred by elk calves. Of the grasses tested, meadow hay was the most preferred. The calves preferred the most succulent and nutritious type of deciduous browse, generally. Ceanothus, if it could have been used throughout the study, would have been highly preferred. As it was, the tests, which were not comparable, indicated that willow was more preferred than serviceberry, as suggested by chemical analysis, which probably accounts for this greater preference. Why the preference for these two browse species should be the exact

opposite the second year of the study is hard to determine. My conclusions would be based on individual animal variation and inadequate sampling.

The genus Pinus contain more turpenes or volatile oils than conifers of other genera. This would appear to have a negative bearing on elk preference for this type of forage; however, lodgepole pine was the more preferred conifer during both years of the study. The exact reason why the calves preferred lodgepole pine to Douglas fir cannot be expressed from the results of this study.

During the winter months, the elk of the Rocky Mountain area may be forced to become browsers instead of grazers due to the inaccessibility of the low growing grasses, either by excessive snow depth or through the withdrawal of their normal wintering areas into agricultural land. A few large elk herds do winter on grass ranges in this region, the Yellowstone and Sun River herds to mention two; however, the more important herds, the ones that produce sport and meat to the hunter, are faced with deep snows and inadequate food supplies during the winter. Winter ranges in these areas should, therefore, be managed to insure the maintenance of the key winter forage, namely, the preferred browse.

THE END

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